

## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

REC'D 16 MAR 2001

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Applicant's or agent's file reference PCT 20351	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US99/27305	International filing date (day/month/year) 18 NOVEMBER 1999	Priority date (day/month/year) 24 NOVEMBER 1998
International Patent Classification (IPC) or national classification and IPC Please See Supplemental Sheet.		
Applicant MERCK & CO., INC.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 7 sheets.
- ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 0 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of report with regard to novelty, inventive step or industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability: citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 07 JUNE 2000	Date of completion of this report 07 FEBRUARY 2001
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# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US99/27305

## I. Basis of the report

1. With regard to the **elements** of the international application:\*

☒ the international application as originally filed  
☒ the description:  
 pages 1-41 , as originally filed  
 pages NONE , filed with the demand  
 pages NONE , filed with the letter of \_\_\_\_\_

☒ the claims:  
 pages 42-49 , as originally filed  
 pages NONE , as amended (together with any statement) under Article 19  
 pages NONE , filed with the demand  
 pages NONE , filed with the letter of \_\_\_\_\_

☒ the drawings:  
 pages 1-8 , as originally filed  
 pages NONE , filed with the demand  
 pages NONE , filed with the letter of \_\_\_\_\_

☒ the sequence listing part of the description:  
 pages 1-6 , as originally filed  
 pages NONE , filed with the demand  
 pages NONE , filed with the letter of \_\_\_\_\_

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.  
 These elements were available or furnished to this Authority in the following language \_\_\_\_\_ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).  
☐ the language of publication of the international application (under Rule 48.3(b)).  
☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☒ contained in the international application in printed form.  
☒ filed together with the international application in computer readable form.  
☐ furnished subsequently to this Authority in written form.  
☐ furnished subsequently to this Authority in computer readable form.  
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.  
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

- ☒ the description, pages NONE  
☒ the claims, Nos. NONE  
☒ the drawings, sheets/fig NONE

5. ☐ This report has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\*Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

## 1. statement

Novelty (N)

Claims 1-33 YESClaims NONE NO

Inventive Step (IS)

Claims 1-33 YESClaims NONE NO

Industrial Applicability (IA)

Claims 1-33 YESClaims NONE NO

## 2. citations and explanations (Rule 70.7)

Claims 1-33 the criteria set out in PCT Article 33(2)-(4), because the prior art does not teach or fairly suggest a purified DNA molecule encoding an HG51 polypeptide, a vector comprising the DNA, a host cell comprising the vector, or a method of determining whether a compound is capable of binding HG51 polypeptide.

----- NEW CITATIONS -----

NONE

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US99/27305

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes I - VIII

Sheet 10

**CLASSIFICATION:**

The International Patent Classification (IPC) and/or the National classification are as listed below:

IPC(7): C07H 21/04; C07K 14/00, 16/28; C12N 1/21, 5/02, 15/00; C12P 21/00; G01N 33/53, 33/567 and US Cl.:  
435/7.2, 69.1, 252.3, 320.1, 325; 536/23.1; 530/350, 387.9

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International Bureau

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>7</sup> :C07H 21/04, C07K 14/00, 16/28, C12N  
1/21, 5/02, 15/00, C12P 21/00, G01N  
33/53, 33/567

A1

(11) International Publication Number:

WO 00/31108

(43) International Publication Date:

2 June 2000 (02.06.00)

(21) International Application Number: PCT/US99/27305

(22) International Filing Date: 18 November 1999 (18.11.99)

(30) Priority Data:

60/109,717

24 November 1998 (24.11.98) US

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Avenue, Rahway, NJ 07065-0907 (US).(74) Common Representative: MERCK & CO., INC.; 126 East  
Lincoln Avenue, Rahway, NJ 07065-0907 (US).(81) Designated States: CA, JP, US, European patent (AT, BE, CH,  
CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL,  
PT, SE).

Published

With international search report.

(54) Title: DNA MOLECULES ENCODING HG51, A G-PROTEIN-COUPLED RECEPTOR

(57) Abstract

A cDNA encoding a novel human G-protein-coupled receptor, HG51, as well as the protein encoded by the cDNA, is provided. Methods of identifying agonists and antagonists of HG51 are also provided.

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## TITLE OF THE INVENTION

DNA MOLECULES ENCODING HG51, A G PROTEIN-COUPLED RECEPTOR

## CROSS-REFERENCE TO RELATED APPLICATIONS

- 5           The present application claims priority to U.S. Serial No. 60/109,717, filed November 24, 1998, which is hereby incorporated by reference.

## FIELD OF THE INVENTION

- 10           The present invention relates to human DNA molecules encoding HG51, a G protein-coupled receptor (GPCR) having homology to the rhodopsin sub-family of GPCRs, recombinant vectors comprising DNA molecules encoding HG51, recombinant host cells which contain a recombinant vector encoding HG51, the HG51 protein encoded by the DNA molecule, and methods of identifying selective modulators of HG51.

15

## BACKGROUND OF THE INVENTION

- 20           G protein-coupled receptors are a large class of membrane receptors that relay information from the exterior to the interior of cells. GPCRs function by interacting with a class of heterotrimeric proteins known as G proteins. Most GPCRs function by a similar mechanism. Upon the binding of an agonist, a GPCR catalyzes the dissociation of guanosine diphosphate (GDP) from the  $\alpha$  subunit of G proteins. This allows for the binding of guanosine triphosphate (GTP) to the  $\alpha$  subunit, resulting in the disassociation of the  $\alpha$  subunit from the  $\beta$  and  $\gamma$  subunits. The freed  $\alpha$  subunit then interacts with other cellular components, and in the process passes on the extracellular signal represented by the presence of the agonist. Occasionally, it is the freed  $\beta$  and  $\gamma$  subunits which transduce the agonist signal.

- 25           GPCRs possess common structural characteristics. They have seven hydrophobic domains, about 20-30 amino acids long, linked by sequences of hydrophilic amino acids of varied length. These seven hydrophobic domains intercalate into the plasma membrane, giving rise to a protein with seven transmembrane domains, an extracellular amino terminus, and an intracellular carboxy terminus (Strader et al., 1994, *Ann. Rev. Biochem.* 63:101-132; Schertler et al., 1993, *Nature* 362:770-772; Dohlman et al., 1991, *Ann. Rev. Biochem.* 60:653-688).

GPCRs are expressed in a wide variety of tissue types and respond to a wide range of ligands, e.g., protein hormones, biogenic amines, peptides, lipid derived messengers, etc. Given their wide range of expression and ligands, it is not surprising that GPCRs are involved in many pathological states. This has led to great interest in  
5 developing modulators of GPCR activity that can be used pharmacologically. For example, Table 1 of Stadel et al. (1997, *Trends Pharmacol. Sci.* 18:430-437), lists 37 different marketed drugs that act upon GPCRs. Accordingly, there is a great need to understand GPCR function and to develop agents that can be used to modulate GPCR activity.

10 Rhodopsin receptors possess the seven transmembrane helices which characterize other GPCRs. Rhodopsin receptors comprise a chromophore-binding pocket which is covalently linked by a protonated Schiff base to a Lys residue in TM 7. For a review of rhodopsin receptors, see Sakmar, 1998, *Progress in Nucleic Acid Research and Molecular Biology* 59: 1-33.

15 It would be advantageous to identify novel members of the rhodopsin subtype of GPCRs which are expressed in a wide variety of tissue and are involved in important metabolic functions. The present invention addresses and meets these needs by disclosing an isolated nucleic acid fragment which expresses a form of human HG51, recombinant vectors which house this nucleic acid fragment,  
20 recombinant host cells which expresses human HG51 and/or a biologically active equivalent, and pharmacological properties of this human HG51 protein.

#### SUMMARY OF THE INVENTION

The present invention relates to an isolated or purified nucleic acid  
25 molecule (polynucleotide) which encodes a novel G protein-coupled receptor, HG51. The nucleic acid molecules of the present invention are substantially free from other nucleic acids.

The present invention relates to an isolated nucleic acid molecule (polynucleotide) which encodes mRNA which expresses a novel G protein-coupled  
30 receptor, HG51, this DNA molecule comprising the nucleotide sequence disclosed herein as SEQ ID NO:1.

The present invention also relates to biologically active fragments or mutants of SEQ ID NO:1 which encodes mRNA expressing a novel G protein-coupled receptor, HG51. Any such biologically active fragment and/or mutant will



encode either a protein or protein fragment which at least substantially mimics the pharmacological properties of a wild-type, HG51 protein, including but not limited to the HG51 receptor protein as set forth in SEQ ID NO:2. Any such polynucleotide includes but is not necessarily limited to nucleotide substitutions, deletions, additions,  
5 amino-terminal truncations and carboxy-terminal truncations such that these mutations encode mRNA which express a protein or protein fragment of diagnostic, therapeutic or prophylactic use and would be useful for screening for agonists and/or antagonists for HG51 function.

A preferred aspect of this portion of the present invention is disclosed  
10 in Figure 1, a human cDNA molecule encoding a novel HG51 (SEQ ID NO:1).

The isolated nucleic acid molecules of the present invention may include a deoxyribonucleic acid molecule (DNA), such as genomic DNA and complementary DNA (cDNA), which may be single (coding or noncoding strand) or double stranded, as well as synthetic DNA, such as a synthesized, single stranded  
15 polynucleotide. The isolated nucleic acid molecule of the present invention may also include a ribonucleic acid molecule (RNA).

The present invention also relates to recombinant vectors and recombinant hosts, both prokaryotic and eukaryotic, which contain the substantially purified nucleic acid molecules disclosed throughout this specification.

20 The present invention also relates to subcellular membrane fractions of the recombinant host cells (both prokaryotic and eukaryotic as well as both stably and transiently transformed cells) which contain the proteins encoded by the nucleic acids of the present invention. These subcellular membrane fractions will comprise either wild-type or mutant forms of human HG51 proteins at levels substantially above  
25 endogenous levels and hence will be useful in various assays described throughout this specification.

The present invention also relates to a substantially purified form of the human HG51 receptor protein, which comprises the amino acid sequence disclosed in Figure 2 and set forth as SEQ ID NO:2.

30 The present invention also relates to biologically active fragments and/or mutants of the G protein-coupled receptor, HG51, comprising the amino acid sequence as set forth in SEQ ID NO:2, including but not necessarily limited to amino acid substitutions, deletions, additions, amino terminal truncations and carboxy-terminal truncations such that these mutations provide for proteins or protein

fragments of diagnostic, therapeutic or prophylactic use and would be useful for screening for selective modulators, including but not limited to agonists and/or antagonists for HG51 function.

A preferred aspect of the present invention is disclosed in Figure 2 and is set forth as SEQ ID NO:2, the amino acid sequence of the novel human G protein-coupled receptor, HG51. HG51 is a novel member of the rhodopsin GPCR family. It is most homologous to the light receptors (opsin) in the eye. Opsins use retinol as the natural ligand. HG51 contains a lysine residue that is critical to form the Schiff base in opsin, suggesting that the ligand of HG51 may be a fatty-acid-like molecule. Since HG51 is expressed in a wide variety of tissue, it should have important functions in metabolism. Potential therapeutic targets of HG51 include but are not limited to obesity and type II diabetes, in view of the possible receptor function involving fatty acid derivatives which are important in obesity/diabetes. In addition, *in situ* data of HG51 suggests that this gene is highly expressed in certain cells of the colon. Therefore, other potential therapeutic targets of HG51 include but are not limited to various GI diseases such as inflammatory bowel disease, constipation and diarrhea.

The present invention also relates to polyclonal and monoclonal antibodies raised in response to either the human form of HG51, or a biologically active fragment thereof.

The present invention also relates to isolated nucleic acid molecules which are fusion constructions expressing fusion proteins useful in assays to identify compounds which modulate wild-type vertebrate HG51.

Therefore, the present invention relates to methods of expressing the human HG51 receptor protein and biological equivalents disclosed herein, assays employing these gene products, recombinant host cells which comprise DNA constructs which express these receptor proteins, and compounds identified through these assays which act as agonists or antagonists of HG51 activity.

The present invention also relates to assays to screen or select for various modulators of HG51 activity, methods of expressing the HG51 protein and biological equivalents disclosed herein, recombinant host cells which comprise DNA constructs which express these receptor proteins, and compounds identified through these assays which act as agonists or antagonists of HG51 activity.

It is an object of the present invention to provide an isolated nucleic acid molecule which encodes a novel form of human HG51, or human HG51

fragments, mutants or derivatives of SEQ ID NO:2. Any such polynucleotide includes but is not necessarily limited to nucleotide substitutions, deletions, additions, amino-terminal truncations and carboxy-terminal truncations such that these mutations encode mRNA which express a protein or protein fragment of diagnostic, therapeutic or prophylactic use and would be useful for screening for selective modulators for vertebrate HG51 function.

It is a further object of the present invention to provide the human HG51 proteins or protein fragments encoded by the nucleic acid molecules referred to in the preceding paragraph.

It is a further object of the present invention to provide recombinant vectors and recombinant host cells which comprise a nucleic acid sequence encoding human HG51 or a biological equivalent thereof.

It is an object of the present invention to provide a substantially purified form of the human HG51 protein, as set forth in SEQ ID NO:2.

It is an object of the present invention to provide for biologically active fragments and/or mutants of the human HG51 protein, such as set forth in SEQ ID NO:2, including but not necessarily limited to amino acid substitutions, deletions, additions, amino terminal truncations and carboxy-terminal truncations such that these mutations provide for proteins or protein fragments of diagnostic, therapeutic and/or prophylactic use.

It is also an object of the present invention to provide for HG51-based in-frame fusion constructions, methods of expressing these fusion constructs, biological equivalents disclosed herein, related assays, recombinant cells expressing these constructs, and agonistic and/or antagonistic compounds identified through the use of the nucleic acid encoding vertebrate, mammalian and/or human HG51 protein as well as the expressed protein.

It is also an object of the present invention to provide for HG51-based assays to select for modulators of this receptor protein. These assays are preferably cell based assays whereby a DNA molecule encoding HG51 is transfected or transformed into a host cell, this recombinant host cell is allowed to grow for a time sufficient to express HG51 prior to use in various assays described herein.

It is a further object to provide for membrane preparations from host cells transfected or transformed with a DNA molecule encoding HG51 for use in assays to select for modulators of HG51 activity.

Therefore, it is an object of the present invention to use HG51, cells transfected with an expression vector which directs the expression of HG51 or membrane preparations containing HG51 or a biological equivalent to screen for modulators, preferably selective modulators, of HG51 activity. Any such compound  
5 may be useful in diagnostic, therapeutic and/or prophylactic indications for such disease states including but not limited to obesity, type II diabetes and various GI diseases including but not limited to inflammatory bowel disease, constipation and diarrhea.

As used herein, "substantially free from other proteins" means at least  
10 90%, preferably 95%, more preferably 99%, and even more preferably 99.9%, free of other proteins. Thus, an HG51 protein preparation that is substantially free from other proteins will contain, as a percent of its total protein, no more than 10%, preferably no more than 5%, more preferably no more than 1%, and even more preferably no more than 0.1%, of non-HG51 proteins. Whether a given HG51 protein  
15 preparation is substantially free from other proteins can be determined by such conventional techniques of assessing protein purity as, *e.g.*, sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) combined with appropriate detection methods, *e.g.*, silver staining or immunoblotting.

As used herein, "substantially free from other nucleic acids" means at  
20 least 90%, preferably 95%, more preferably 99%, and even more preferably 99.9%, free of other nucleic acids. Thus, an HG51 DNA preparation that is substantially free from other nucleic acids will contain, as a percent of its total nucleic acid, no more than 10%, preferably no more than 5%, more preferably no more than 1%, and even more preferably no more than 0.1%, of non-HG51 nucleic acids. Whether a given  
25 HG51 DNA preparation is substantially free from other nucleic acids can be determined by such conventional techniques of assessing nucleic acid purity as, *e.g.*, agarose gel electrophoresis combined with appropriate staining methods, *e.g.*, ethidium bromide staining, or by sequencing.

As used interchangeably herein, "functional equivalent" or  
30 "biologically active equivalent" means a receptor which does not have exactly the same amino acid sequence as naturally occurring HG51, due to alternative splicing, deletions, mutations, substitutions, or additions, but retains substantially the same biological activity as HG51. Such functional equivalents will have significant amino acid sequence identity with naturally occurring HG51 and genes and cDNA encoding

such functional equivalents can be detected by reduced stringency hybridization with a DNA sequence encoding naturally occurring HG51. For the purposes of this invention, naturally occurring HG51 has the amino acid sequence shown as SEQ ID NO:2 and is encoded by SEQ ID NO:1. A nucleic acid encoding a functional  
5 equivalent has at least about 50% identity at the nucleotide level to SEQ ID NO:1.

A polypeptide has "substantially the same biological activity" as HG51 if that polypeptide has a  $K_d$  for a ligand that is no more than 5-fold greater than the  $K_d$  of HG51 having SEQ ID NO:2 for the same ligand.

As used herein, "a conservative amino acid substitution" refers to the  
10 replacement of one amino acid residue by another, chemically similar, amino acid residue. Examples of such conservative substitutions are: substitution of one hydrophobic residue (isoleucine, leucine, valine, or methionine) for another; substitution of one polar residue for another polar residue of the same charge (*e.g.*, arginine for lysine; glutamic acid for aspartic acid).

As used interchangeably herein, "isolated HG51 protein" or "purified  
15 HG51 protein" refers to HG51 protein that has been isolated from a natural source. Use of the term "isolated" or "purified" indicates that HG51 protein has been removed from its normal cellular environment. Thus, an isolated HG51 protein may be in a cell-free solution or placed in a different cellular environment from that in which it  
20 occurs naturally. The term isolated does not imply that an isolated HG51 protein is the only protein present, but instead means that an isolated HG51 protein is substantially free of other proteins and non-amino acid material (*e.g.*, nucleic acids, lipids, carbohydrates) naturally associated with the HG51 protein *in vivo*. Thus, an  
25 HG51 protein that is expressed in a prokaryotic or eukaryotic cell which do not naturally (*i.e.*, without human intervention) express it through recombinant means is an "isolated HG51 protein."

As used herein, "GPCR" refers to --G protein-coupled receptor--.

As used herein, the term "mammalian host" will refer to any mammal,  
including a human being.

30

#### BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows the nucleotide sequence which encodes human HG51, as set forth in SEQ ID NO:1.

Figure 2 shows the amino acid sequence of human HG51, as set forth in SEQ ID NO:2.

Figures 3A, 3B, and 3C show the translation of the HG51 open reading frame. The nucleotide sequence shown is as set forth in SEQ ID NO:1. The amino acid sequence shown is as set forth in SEQ ID NO:2.

Figures 4A, 4B, 4C, 4D, and 4E show multi-tissue Northern analysis of mRNA which encodes human HG51

Figure 5 shows an alignment of a portion of the amino acid sequence of HG51 (as contained within SEQ ID NO:2) with the amino acid sequence of the human rhodopsin receptor (SEQ ID NO:15).

#### DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to an isolated nucleic acid molecule (polynucleotide) which encodes a novel human GPCR, HG51, which shows homology to the human rhodopsin receptor. The nucleic acid molecules of the present invention are substantially free from other nucleic acids. For most cloning purposes, DNA is a preferred nucleic acid.

The present invention relates to an isolated nucleic acid molecule (polynucleotide) which encodes mRNA which expresses a novel human HG51 GPCR, this DNA molecule comprising the nucleotide sequence disclosed herein as SEQ ID NO:1, shown herein as follows:

```

GGGGCCACGG GGGGTGCGCC GGCGCGCGGT AGCGCGGGCC CCTCAGTGCA CAATGGCCAG
AGCAGGCGGC GGAGCCCCAG CCCCACCCAG TGCGGAGCGC GCCGCGAGCC CCGCCGCAAG
CTGAGCGCCT CCGCCCGCCA GGCGCGCCGG CGCCGGGCCA TGTACTCGGG GAACCGCAGC
25 GGCggccacg GCTACTGGGA CGGCGGCGGG GCCGCGGGCG CTGAGGGGCC GGCGCCGGCG
GGGACACTGA GCGCCGCGCC CCTCTTCAGC CCCGGCACCT ACGAGCGCCT GCGCTGCTG
CTGGGCTCCA TTGGGCTGCT GGGCGTCGGC AACAACTGC TGGTGCTCGT CCTTACTAC
AAGTTCCAGC GGCTCCGCAC TCCCACTCAC CTCCTCCTGG TCAACATCAG CCTCAGCGAC
CTGCTGGTGT CCCTCTTCGG GGTCACTTTT ACCTTCGTGT CCTGCCTGAG GAACGGCTGG
30 GTGTGGGACA CCGTGGGCTG CGTGTGGGAC GGGTTTAGCG GCAGCCTCTT CGGGATTGTT
TCCATTGCCA CCCTAACCGT GCTGGCCTAT GAACGTTACA TTCGCGTGGT CCATGCCAGA
GTGATCAATT TTTCTGGGC CTGGAGGGCC ATTACCTACA TCTGGCTCTA CTCACTGGCG
TGGGCAGGAG CACCTCTCCT GGGATGGAAC AGGTACATCC TGGACGTACA CGGACTAGGC
TGCACTGTGG ACTGGAATC CAAGGATGCC AACGATTCCT CCTTGTGCT TTTCTATTT

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CTTGGCTGCC TGGTGGTGCC CCTGGGTGTC ATAGCCCATT GCTATGGCCA TATTCTATAT  
 TCCATTTCGAA TGCTTCGTTG TGTGGAAGAT CTTGAGACAA TTCAAGTGAT CAAGATTTTA  
 AAATATGAAA AGAACTGGC CAAAATGTGC TTTTAAATGA TATTCACCTT CCTGGTCTGT  
 TGGATGCCTT ATATCGTGAT CTGCTCTTGT GTGGTTAATG GTCATGGTCA CCTGGTCACT  
 5 CCAACAATAT CTATTGTTTC GTACCTCTTT GCTAAATCGA AACTGTATA CAATCCAGTG  
 ATTTATGTCT TCATGATCAG AAAGTTTCGA AGATCCCTTT TGCAGCTTCT GTGCCTCCGA  
 CTGCTGAGGT GCCAGAGGCC TGCTAAAGAC CTACCAGCAG CTGGAAGTGA AATGCAGATC  
 AGACCCATTG TGATGTCACA GAAAGATGGG GACAGGCCAA AGAAAAAGT GACTTTCAAC  
 TCTTCTTCCA TCATTTTAT CATACCAGT GATGAATCAC TGTCAGTTGA CGACAGCGAC  
 10 AAAACCAATG GGTCCAAAGT TGATGTAATC CAAGTTCGTC CTTGTAGGA ATGAAGAATG  
 GCAACGAAAG ATGGGGCCTT AAATTGGATG CCACTTTTGG ACTTTCATCA TAAGAAGTGT  
 CTGGAATACC CGTTCTATGT AATATCAACA GAACCTTGTG GTCCAGCAGG AAATCCGAAT  
 TGCCCATATG CTCTTGGGCC TCAGGAAGAG GTTGAAC (SEQ ID NO:1)

The above-exemplified isolated DNA molecule, shown in Figure 1 and  
 15 set forth as SEQ ID NO:1, contains 1537 nucleotides. This DNA molecule contains  
 an open reading frame from nucleotide 160 to nucleotide 1365, with a "TAG"  
 termination codon from nucleotides 1366-1368. This open reading frame encodes a  
 human HG51 GPCR, which shares homology to human rhodopsin. The HG51  
 protein contains an open reading frame of 402 amino acids in length, as shown in  
 20 Figure 2 and as set forth in SEQ ID NO:2. One partial cDNA sequence (EST)  
 (Genbank accession number aa745052) was found by searching the EST database  
 using protein sequences of G protein-coupled receptors. DNA sequence information  
 of this EST was then used to isolate cDNA fragments containing the original ESTs.  
 DNA sequences of these fragments were determined and analyzed, resulting in the  
 25 identification of the full-length coding sequence of the gene designated HG51.  
 Northern analysis of multi-tissue mRNA blots showed that HG51 was weakly  
 expressed in many tissues as transcripts of ~8.0 - 9.0 kb and ~2.0 - 2.5 kb.  
 Expression of HG51 in HEK293 cells led to the increase in intracellular cAMP level,  
 indicating that HG51 is coupled to the Gs protein.

30 The present invention also relates to biologically active fragments or  
 mutants of SEQ ID NO:1 which encodes mRNA expressing HG51. Any such  
 biologically active fragment and/or mutant will encode either a protein or protein  
 fragment which at least substantially mimics the pharmacological properties of human  
 HG51 protein, including but not limited to the human HG51 receptor protein as set

forth in SEQ ID NO:2. Any such polynucleotide includes but is not necessarily limited to nucleotide substitutions, deletions, additions, amino-terminal truncations and carboxy-terminal truncations such that these mutations encode mRNA which express a protein or protein fragment of diagnostic, therapeutic or prophylactic use and would be useful for screening for agonists and/or antagonists for HG51 function.

A preferred aspect of this portion of the present invention is disclosed in Figure 1, a cDNA molecule encoding human HG51 (SEQ ID NO:1).

The isolated nucleic acid molecules of the present invention may include a deoxyribonucleic acid molecule (DNA), such as genomic DNA and complementary DNA (cDNA), which may be single (coding or noncoding strand) or double stranded, as well as synthetic DNA, such as a synthesized, single stranded polynucleotide. The isolated nucleic acid molecule of the present invention may also include a ribonucleic acid molecule (RNA).

The degeneracy of the genetic code is such that, for all but two amino acids, more than a single codon encodes a particular amino acid. This allows for the construction of synthetic DNA that encodes the HG51 protein where the nucleotide sequence of the synthetic DNA differs significantly from the nucleotide sequence of SEQ ID NO: 1, but still encodes the same HG51 protein as SEQ ID NO: 1. Such synthetic DNAs are intended to be within the scope of the present invention. If it is desired to express such synthetic DNAs in a particular host cell or organism, the codon usage of such synthetic DNAs can be adjusted to reflect the codon usage of that particular host, thus leading to higher levels of expression of HG51 protein in the host. In other words, this redundancy in the various codons which code for specific amino acids is within the scope of the present invention. Therefore, this invention is also directed to those DNA sequences which encode RNA comprising alternative codons which code for the eventual translation of the identical amino acid, as shown below:

A=Ala=Alanine: codons GCA, GCC, GCG, GCU

C=Cys=Cysteine: codons UGC, UGU

D=Asp=Aspartic acid: codons GAC, GAU

E=Glu=Glutamic acid: codons GAA, GAG

F=Phe=Phenylalanine: codons UUC, UUU

G=Gly=Glycine: codons GGA, GGC, GGG, GGU

H=His=Histidine: codons CAC, CAU



- I=Ile=Isoleucine: codons AUA, AUC, AUU  
K=Lys=Lysine: codons AAA, AAG  
L=Leu=Leucine: codons UUA, UUG, CUA, CUC, CUG, CUU  
M=Met=Methionine: codon AUG  
5 N=Asp=Asparagine: codons AAC, AAU  
P=Pro=Proline: codons CCA, CCC, CCG, CCU  
Q=Gln=Glutamine: codons CAA, CAG  
R=Arg=Arginine: codons AGA, AGG, CGA, CGC, CGG, CGU  
S=Ser=Serine: codons AGC, AGU, UCA, UCC, UCG, UCU  
10 T=Thr=Threonine: codons ACA, ACC, ACG, ACU  
V=Val=Valine: codons GUA, GUC, GUG, GUU  
W=Trp=Tryptophan: codon UGG  
Y=Tyr=Tyrosine: codons UAC, UAU

- Therefore, the present invention discloses codon redundancy which  
15 may result in differing DNA molecules expressing an identical protein. For  
purposes of this specification, a sequence bearing one or more replaced codons  
will be defined as a degenerate variation. Also included within the scope of this  
invention are mutations either in the DNA sequence or the translated protein  
which do not substantially alter the ultimate physical properties of the expressed  
20 protein. For example, substitution of valine for leucine, arginine for lysine, or  
asparagine for glutamine may not cause a change in functionality of the  
polypeptide.

- It is known that DNA sequences coding for a peptide may be altered so  
as to code for a peptide having properties that are different than those of the naturally  
25 occurring peptide. Methods of altering the DNA sequences include but are not  
limited to site directed mutagenesis. Examples of altered properties include but are  
not limited to changes in the affinity of an enzyme for a substrate or a receptor for a  
ligand.

- The present invention also relates to recombinant vectors and  
30 recombinant hosts, both prokaryotic and eukaryotic, which contain the substantially  
purified nucleic acid molecules disclosed throughout this specification. The nucleic  
acid molecules of the present invention encoding HG51, in whole or in part, can be  
linked with other DNA molecules, i.e., DNA molecules to which the human HG51  
are not naturally linked, to form "recombinant DNA molecules" containing the

receptor. The novel DNA sequences of the present invention can be inserted into vectors which comprise nucleic acids encoding human HG51 or a functional equivalent.

5 These vectors may be comprised of DNA or RNA; for most cloning purposes DNA vectors are preferred. Typical vectors include plasmids, modified viruses, bacteriophage, cosmids, yeast artificial chromosomes, and other forms of episomal or integrated DNA that can encode a HG51 receptor protein. It is well within the skilled artisan to determine an appropriate vector for a particular gene transfer or other use.

10 Included in the present invention are DNA sequences that hybridize to SEQ ID NO:1 under stringent conditions. By way of example, and not limitation, a procedure using conditions of high stringency is as follows: prehybridization of filters containing DNA is carried out for 2 hours to overnight at 65°C in buffer composed of 6X SSC, 5X Denhardt's solution, and 100 µg/ml denatured salmon sperm DNA.  
15 Filters are hybridized for 12 to 48 hours at 65°C in prehybridization mixture containing 100 µg/ml denatured salmon sperm DNA and 5-20 X 10<sup>6</sup> cpm of <sup>32</sup>P-labeled probe. Washing of filters is done at 37°C for 1 hour in a solution containing 2X SSC, 0.1% SDS. This is followed by a wash in 0.1X SSC, 0.1% SDS at 50°C for 45 minutes before autoradiography. Other procedures using conditions of high  
20 stringency would include either a hybridization step carried out in 5XSSC, 5X Denhardt's solution, 50% formamide at 42°C for 12 to 48 hours or a washing step carried out in 0.2X SSPE, 0.2% SDS at 65°C for 30 to 60 minutes.

Reagents mentioned in the foregoing procedures for carrying out high stringency hybridization are well known in the art. Details of the composition of  
25 these reagents can be found in, e.g., Sambrook et al., 1989, *Molecular Cloning: A Laboratory Manual*; Cold Spring Harbor Laboratory, Cold Spring Harbor, New York. In addition to the foregoing, other conditions of high stringency which may be used are well known in the art.

30 The present invention also relates to a substantially purified form of the human HG51 receptor protein, which comprises the amino acid sequence disclosed in Figure 2 and as set forth in SEQ ID NO:2.

The present invention also relates to biologically active fragments and/or mutants of the human HG51 receptor protein comprising the amino acid sequence as set forth in SEQ ID NO:2, including but not necessarily limited to amino

acid substitutions, deletions, additions, amino terminal truncations and carboxy-terminal truncations such that these mutations provide for proteins or protein fragments of diagnostic, therapeutic or prophylactic use and would be useful for screening for agonists and/or antagonists of HG51 function.

5 A preferred aspect of the present invention is disclosed in Figure 2 and is set forth as SEQ ID NO:2 in three letter code, and as herein set forth as follows in one letter code:

10 MYSGNRSGGH GYWDGGGAAG AEGPAPAGTL SPAPLFSPGT YERLALLLGS IGLLGVGNNL  
LVLVLYYKFQ RLRTPTHLLL VNISLSDLLV SLFGVTFTFV SCLRNGVWVD TVGCVWDGFS  
GSLFGIVSIA TLTVLAYERY IRVVHARVIN FSWAWRAITY IWLYSLAWAG APLLGWNRYY  
LDVHGLGCTV DWKSKDANDS SFVLFLFLGC LVVPLGVIAH CYGHILYSIR MLRCVEDLQT  
IQVIKILKYE KKLAKMCFM IFTFLVCWMP YIVICFLVVN GHGHLVTPTI SIVSYLFAKS  
NTVYNPVIYV FMIRKFRRSL LQLLCLRLLR QORPAKDLPA AGSEMQRPI VMSQKGDGRP  
15 KKKVTFNSSS IIFIITSDES LSVDDSDKTN GSKVDVIQVR PL (SEQ ID NO:2), which  
comprises the amino acid sequence of wild type human HG51 receptor protein.

As with many receptor proteins, it is possible to modify many of the amino acids of HG51, particularly those which are not found in the ligand binding domain, and still retain substantially the same biological activity as the original receptor. Thus this invention includes modified HG51 polypeptides which have  
20 amino acid deletions, additions, or substitutions but that still retain substantially the same biological activity as HG51. Accordingly, the present invention includes polypeptides where one amino acid substitution has been made in SEQ ID NO:2 wherein the polypeptides still retain substantially the same biological activity as HG51. The present invention also includes polypeptides where two or more amino  
25 acid substitutions have been made in SEQ ID NO:2 wherein the polypeptides still retain substantially the same biological activity as HG51. In particular, the present invention includes embodiments where the above-described substitutions are conservative substitutions. In particular, the present invention includes embodiments where the above-described substitutions do not occur in the ligand-binding domain of  
30 HG51.

When deciding which amino acid residues of HG51 may be substituted to produce polypeptides that are functional equivalents of HG51, one skilled in the art would be guided by a comparison of the amino acid sequence of HG51 with the amino acid sequences of related proteins, *e.g.*, the human rhodopsin receptor as

shown in Figure 5 of the present specification. Such a comparison would allow one skilled in the art to minimize the number of amino acid substitutions made in regions that are highly conserved between HG51 and the related protein. Accordingly, the present invention includes embodiments where the substitutions are conservative and do not occur in positions where HG51 and the human rhodopsin receptor share the same amino acid (again, see Figure 5).

One skilled in the art would also recognize that polypeptides that are functional equivalents of HG51 and have changes from the HG51 amino acid sequence that are small deletions or insertions of amino acids could also be produced by following the same guidelines, (i.e., minimizing the differences in amino acid sequence between HG51 and related proteins). Small deletions or insertions are generally in the range of about 1 to 5 amino acids. The effect of such small deletions or insertions on the biological activity of the modified HG51 polypeptide can easily be assayed by producing the polypeptide synthetically or by making the required changes in DNA encoding HG51 and then expressing the DNA recombinantly and assaying the protein produced by such recombinant expression.

The present invention also includes C-terminal truncated forms of HG51, particularly those which encompass the extracellular portion of the receptor, but lack the intracellular signaling portion of the receptor. Such truncated receptors are useful in various binding assays described herein, for crystallization studies, and for structure-activity-relationship studies.

The present invention also includes chimeric HG51 proteins. Chimeric HG51 proteins consist of a contiguous polypeptide sequence of HG51 fused in frame to a polypeptide sequence of a non-HG51 protein. For example, the N-terminal domain and seven transmembrane spanning domains of HG51 fused at the C-terminus in frame to a G protein would be a chimeric HG51 protein.

The present invention also includes HG51 proteins that are in the form of multimeric structures, e.g., dimers. Such multimers of other G-protein coupled receptors are known (Hebert *et al.*, 1996, *J. Biol. Chem.* 271, 16384-16392; Ng *et al.*, 1996, *Biochem. Biophys. Res. Comm.* 227, 200-204; Romano *et al.*, 1996, *J. Biol. Chem.* 271, 28612-28616).

The present invention also relates to subcellular membrane fractions from the recombinant host cells (both prokaryotic and eukaryotic as well as both stably and transiently transformed cells) which contain the nucleic acid molecules of

the present invention. These recombinant host cells express HG51 or a functional equivalent, which becomes associated with the appropriate membrane (such as the cell membrane) in a biologically active fashion. These subcellular membrane fractions will comprise either wild-type or mutant forms of human HG51 receptor proteins at levels substantially above endogenous levels and hence will be useful in various assays described throughout this specification.

The present invention also relates to polyclonal and monoclonal antibodies raised in response to either the human form of HG51, or a biologically active equivalent thereof.

The present invention also relates to isolated nucleic acid molecules which are fusion constructions expressing fusion proteins useful in assays to identify compounds which modulate wild-type vertebrate HG51 activity. A preferred aspect of this portion of the invention includes, but is not limited to, glutathione S-transferase (GST)-HG51 fusion constructs which include, but are not limited to, either the intracellular domain of human HG51 as an in-frame fusion at the carboxy terminus of the GST gene or the extracellular and transmembrane ligand binding domain of HG51 fused to an GST or immunoglobulin gene by methods known to one of ordinary skill in the art. Recombinant GST-HG51 fusion proteins may be expressed in various expression systems, including *Spodoptera frugiperda* (Sf21) insect cells (Invitrogen) using a baculovirus expression vector (pAcG2T, Pharmingen).

Based on its predicted amino acid sequence, the HG51 protein represents a novel G-protein coupled receptor (GPCR) since the HG51 protein contains many of the characteristic features of G-protein coupled receptors (GPCRs), including but not necessarily limited to (a) seven transmembrane domains; (b) homology with members of the rhodopsin family of GPCRs; and, (c) signature motifs of GPCRs in the rhodopsin family, such as a conserved NPXXY motif in transmembrane domain 7 (amino acid residue 305 to 309).

As with many receptor proteins, it is possible to modify many of the amino acids, particularly those which are not found in the ligand binding domain, and still retain substantially the same biological activity as the original receptor. Thus this invention includes modified HG51 polypeptides which have amino acid deletions, additions, or substitutions but that still retain substantially the same biological activity as HG51. It is generally accepted that single amino acid substitutions do not usually

alter the biological activity of a protein (see, e.g., *Molecular Biology of the Gene*, Watson et al., 1987, Fourth Ed., The Benjamin/Cummings Publishing Co., Inc., page 226; and Cunningham & Wells, 1989, *Science* 244:1081-1085). Accordingly, the present invention includes isolated nucleic acid molecules and expressed HG51  
5 proteins wherein one amino acid substitution is generated and which this protein retains substantially the same biological activity as wild-type HG51. The present invention also includes isolated nucleic acid molecules and expressed HG51 proteins wherein two or more amino acid substitution is generated wherein this protein retains substantially the same biological activity as wild-type HG51. In particular, the  
10 present invention includes embodiments where the above-described substitutions are conservative substitutions. In particular, the present invention includes embodiments where the above-described substitutions do not occur in the ligand-binding domain of HG51.

Any of a variety of procedures may be used to clone human HG51.  
15 These methods include, but are not limited to, (1) a RACE PCR cloning technique (Frohman, et al., 1988, *Proc. Natl. Acad. Sci. USA* 85: 8998-9002). 5' and/or 3' RACE may be performed to generate a full-length cDNA sequence. This strategy involves using gene-specific oligonucleotide primers for PCR amplification of human HG51 cDNA. These gene-specific primers are designed through identification of an  
20 expressed sequence tag (EST) nucleotide sequence which has been identified by searching any number of publicly available nucleic acid and protein databases; (2) direct functional expression of the human HG51 cDNA following the construction of a human HG51-containing cDNA library in an appropriate expression vector system; (3) screening a human HG51-containing cDNA library constructed in a bacteriophage  
25 or plasmid shuttle vector with a labeled degenerate oligonucleotide probe designed from the amino acid sequence of the human HG51 protein; (4) screening a human HG51-containing cDNA library constructed in a bacteriophage or plasmid shuttle vector with a partial cDNA encoding the human HG51 protein. This partial cDNA is obtained by the specific PCR amplification of human HG51 DNA fragments through  
30 the design of degenerate oligonucleotide primers from the amino acid sequence known for other kinases which are related to the human HG51 protein; (5) screening a human HG51-containing cDNA library constructed in a bacteriophage or plasmid shuttle vector with a partial cDNA or oligonucleotide with homology to a mammalian HG51 protein. This strategy may also involve using gene-specific oligonucleotide

primers for PCR amplification of human HG51 cDNA identified as an EST as described above; or (6) designing 5' and 3' gene specific oligonucleotides using SEQ ID NO: 1 as a template so that either the full-length cDNA may be generated by known RACE techniques, or a portion of the coding region may be generated by these same known RACE techniques to generate and isolate a portion of the coding region to use as a probe to screen one of numerous types of cDNA and/or genomic libraries in order to isolate a full-length version of the nucleotide sequence encoding human HG51.

It is readily apparent to those skilled in the art that other types of libraries, as well as libraries constructed from other cell types or species types, may be useful for isolating a human HG51-encoding DNA or a human HG51 homologue. Other types of libraries include, but are not limited to, cDNA libraries derived from other rhesus cells.

It is readily apparent to those skilled in the art that suitable cDNA libraries may be prepared from cells or cell lines which have HG51 activity. The selection of cells or cell lines for use in preparing a cDNA library to isolate a cDNA encoding human HG51 may be done by first measuring cell-associated HG51 activity using any known assay available for such a purpose.

Preparation of cDNA libraries can be performed by standard techniques well known in the art. Well known cDNA library construction techniques can be found for example, in Sambrook et al., 1989, *Molecular Cloning: A Laboratory Manual*; Cold Spring Harbor Laboratory, Cold Spring Harbor, New York. Complementary DNA libraries may also be obtained from numerous commercial sources, including but not limited to Clontech Laboratories, Inc. and Stratagene.

It is also readily apparent to those skilled in the art that DNA encoding human HG51 may also be isolated from a suitable genomic DNA library. Construction of genomic DNA libraries can be performed by standard techniques well known in the art. Well known genomic DNA library construction techniques can be found in Sambrook, et al., *supra*. Genomic clones containing the HG51 gene can be obtained from commercially available human PAC or BAC libraries, e.g., from Research Genetics, Huntsville, AL. Alternatively, one may prepare genomic libraries, especially in P1 artificial chromosome vectors, from which genomic clones containing the HG51 can be isolated, using probes based upon the HG51 nucleotide

sequences disclosed herein. Methods of preparing such libraries are known in the art (Ioannou et al., 1994, *Nature Genet.* 6:84-89).

In order to clone the human HG51 gene by one of the preferred methods, it may be necessary to obtain at least a portion of the amino acid sequence or DNA sequence of human HG51 or a homologous protein. To accomplish this, the HG51 protein or a homologous protein may be purified and partial amino acid sequence determined by automated sequenators. It is not necessary to determine the entire amino acid sequence, but the linear sequence of two regions of 6 to 8 amino acids can be determined for the PCR amplification of a partial human HG51 DNA fragment. Once suitable amino acid sequences have been identified, the DNA sequences capable of encoding them are synthesized. Because the genetic code is degenerate, more than one codon may be used to encode a particular amino acid, and therefore, the amino acid sequence can be encoded by any of a set of similar DNA oligonucleotides. Only one member of the set will be identical to the human HG51 sequence but others in the set will be capable of hybridizing to human HG51 DNA even in the presence of DNA oligonucleotides with mismatches. The mismatched DNA oligonucleotides may still sufficiently hybridize to the human HG51 DNA to permit identification and isolation of human HG51 encoding DNA. Alternatively, the nucleotide sequence of a region of an expressed sequence may be identified by searching one or more available genomic databases. Gene-specific primers may be used to perform PCR amplification of a cDNA of interest from either a cDNA library or a population of cDNAs. As noted above, the appropriate nucleotide sequence for use in a PCR-based method may be obtained from SEQ ID NO: 1, either for the purpose of isolating overlapping 5' and 3' RACE products for generation of a full-length sequence coding for human HG51, or to isolate a portion of the nucleotide sequence coding for human HG51 for use as a probe to screen one or more cDNA- or genomic-based libraries to isolate a full-length sequence encoding human HG51 or human HG51-like proteins.

This invention also includes vectors containing a HG51 gene, host cells containing the vectors, and methods of making substantially pure HG51 protein comprising the steps of introducing the HG51 gene into a host cell, and cultivating the host cell under appropriate conditions such that HG51 is produced. The HG51 so produced may be harvested from the host cells in conventional ways. Therefore, the present invention also relates to methods of expressing the human HG51 protein and



biological equivalents disclosed herein, assays employing these gene products, recombinant host cells which comprise DNA constructs which express these receptor proteins, and compounds identified through these assays which act as agonists or antagonists of HG51 activity.

5           The cloned human HG51 cDNA obtained through the methods described above may be recombinantly expressed by molecular cloning into an expression vector (such as pcDNA3.neo, pcDNA3.1, pCR2.1, pBlueBacHis2 or pLITMUS28) containing a suitable promoter and other appropriate transcription regulatory elements, and transferred into prokaryotic or eukaryotic host cells to  
10   produce recombinant human HG51. Techniques for such manipulations can be found described in Sambrook, et al., *supra*, are discussed in the Example sections and are well known and easily available to the artisan of ordinary skill in the art. Therefore, another aspect of the present invention includes host cells that have been engineered to contain and/or express DNA sequences encoding the HG51. An expression vector  
15   containing DNA encoding a human HG51-like protein may be used for expression of human HG51 in a recombinant host cell. Such recombinant host cells can be cultured under suitable conditions to produce HG51 or a biologically equivalent form. Recombinant host cells may be prokaryotic or eukaryotic, including but not limited to, bacteria such as *E. coli*, fungal cells such as yeast, mammalian cells including, but  
20   not limited to, cell lines of human, bovine, porcine, monkey and rodent origin, and insect cells including but not limited to *Drosophila* and silkworm derived cell lines.

For instance, one insect expression system utilizes *Spodoptera frugiperda* (Sf21) insect cells (Invitrogen) in tandem with a baculovirus expression vector (pAcG2T, Pharmingen). Also, mammalian species which may be suitable and  
25   which are commercially available, include but are not limited to, L cells L-M (TK-) (ATCC CCL 1.3), L cells L-M (ATCC CCL 1.2), Saos-2 (ATCC HTB-85), 293 (ATCC CRL 1573), Raji (ATCC CCL 86), CV-1 (ATCC CCL 70), COS-1 (ATCC CRL 1650), COS-7 (ATCC CRL 1651), CHO-K1 (ATCC CCL 61), 3T3 (ATCC CCL 92), NIH/3T3 (ATCC CRL 1658), HeLa (ATCC CCL 2), C1271 (ATCC CRL  
30   1616), BS-C-1 (ATCC CCL 26), MRC-5 (ATCC CCL 171) and CPAE (ATCC CCL 209).

Human embryonic kidney (HEK 293) cells and Chinese hamster ovary (CHO) cells are particularly suitable for expression of the HG51 protein because these cells express a large number of G-proteins. Thus, it is likely that at least one of these

G-proteins will be able to functionally couple the signal generated by interaction of HG51 and its ligands, thus transmitting this signal to downstream effectors, eventually resulting in a measurable change in some assayable component, e.g., cAMP level, expression of a reporter gene, hydrolysis of inositol lipids, or  
5 intracellular  $Ca^{++}$  levels.

Other cells that are particularly suitable for expression of the HG51 protein are immortalized melanophore pigment cells from *Xenopus laevis*. Such melanophore pigment cells can be used for functional assays using recombinant expression of HG51 in a manner similar to the use of such melanophore pigment cells  
10 for the functional assay of other recombinant GPCRs (Graminski et al., 1993, *J. Biol. Chem.* 268:5957-5964; Lerner, 1994, *Trends Neurosci.* 17:142-146; Potenza & Lerner, 1992, *Pigment Cell Res.* 5: 372-378).

A variety of mammalian expression vectors may be used to express recombinant human HG51 in mammalian cells. Expression vectors are defined  
15 herein as DNA sequences that are required for the transcription of cloned DNA and the translation of their mRNAs in an appropriate host. Such vectors can be used to express eukaryotic DNA in a variety of hosts such as bacteria, blue green algae, plant cells, insect cells and animal cells. Specifically designed vectors allow the shuttling of DNA between hosts such as bacteria-yeast or bacteria-animal cells. An  
20 appropriately constructed expression vector should contain: an origin of replication for autonomous replication in host cells, selectable markers, a limited number of useful restriction enzyme sites, a potential for high copy number, and active promoters. A promoter is defined as a DNA sequence that directs RNA polymerase to bind to DNA and initiate RNA synthesis. A strong promoter is one which causes  
25 mRNAs to be initiated at high frequency.

Expression vectors may include, but are not limited to, cloning vectors, modified cloning vectors, specifically designed plasmids or viruses. Commercially available mammalian expression vectors which may be suitable for recombinant human HG51 expression, include but are not limited to, pIRES-hyg  
30 (Clontech), pIRES-puro (Clontech), pcDNA3.neo (Invitrogen), pcDNA3.1 (Invitrogen), pCI-neo (Promega), pLITMUS28, pLITMUS29, pLITMUS38 and pLITMUS39 (New England Biolabs), pcDNA1, pcDNA1amp (Invitrogen), pcDNA3 (Invitrogen), pMC1neo (Stratagene), pXT1 (Stratagene), pSG5 (Stratagene), EBO-pSV2-neo (ATCC 37593) pBPV-1(8-2) (ATCC 37110), pdBPV-MMTneo(342-12)

(ATCC 37224), pRSVgpt (ATCC 37199), pRSVneo (ATCC 37198), pSV2-dhfr (ATCC 37146), pUCTag (ATCC 37460), and IZD35 (ATCC 37565).

Also, a variety of bacterial expression vectors may be used to express recombinant human HG51 in bacterial cells. Commercially available bacterial  
5 expression vectors which may be suitable for recombinant human HG51 expression include, but are not limited to pCR2.1 (Invitrogen), pET11a (Novagen), lambda gt11 (Invitrogen), and pKK223-3 (Pharmacia).

In addition, a variety of fungal cell expression vectors may be used to express recombinant human HG51 in fungal cells. Commercially available fungal  
10 cell expression vectors which may be suitable for recombinant human HG51 expression include but are not limited to pYES2 (Invitrogen) and *Pichia* expression vector (Invitrogen).

Also, a variety of insect cell expression vectors may be used to express recombinant receptor in insect cells. Commercially available insect cell expression  
15 vectors which may be suitable for recombinant expression of human HG51 include but are not limited to pBlueBacIII and pBlueBacHis2 (Invitrogen), and pAcG2T (Pharmingen).

The assays described herein can be carried out with cells that have been transiently or stably transfected or transformed with an expression vector which  
20 directs expression of HG51. The expression vector may be introduced into host cells via any one of a number of techniques including but not limited to transformation, transfection, protoplast fusion, and electroporation. Transformation is meant to encompass a genetic change to the target cell resulting from an incorporation of DNA. Transfection is meant to include any method known in the art for introducing  
25 HG51 into the test cells. For example, transfection includes calcium phosphate or calcium chloride mediated transfection, lipofection, electroporation, as well as infection with, for example, a viral vector such as a recombinant retroviral vector containing the nucleotide sequence which encodes HG51, and combinations thereof. The expression vector-containing cells are individually analyzed to determine  
30 whether they produce human HG51 protein. Identification of human HG51 expressing cells may be done by several means, including but not limited to immunological reactivity with anti-human HG51 antibodies, labeled ligand binding and the presence of host cell-associated human HG51 activity.

Expression of human HG51 DNA may also be performed using *in vitro* produced synthetic mRNA. Synthetic mRNA can be efficiently translated in various cell-free systems, including but not limited to wheat germ extracts and reticulocyte extracts, as well as efficiently translated in cell based systems, including  
5 but not limited to microinjection into frog oocytes, with microinjection into frog oocytes being preferred.

To determine the human HG51 cDNA sequence(s) that yields optimal levels of human HG51, cDNA molecules including but not limited to the following can be constructed: a cDNA fragment containing the full-length open reading frame  
10 for human HG51 as well as various constructs containing portions of the cDNA encoding only specific domains of the protein or rearranged domains of the protein. All constructs can be designed to contain none, all or portions of the 5' and/or 3' untranslated region of a human HG51 cDNA. The expression levels and activity of human HG51 can be determined following the introduction, both singly and in  
15 combination, of these constructs into appropriate host cells. Following determination of the human HG51 cDNA cassette yielding optimal expression in transient assays, this HG51 cDNA construct is transferred to a variety of expression vectors (including recombinant viruses), including but not limited to those for mammalian cells, plant cells, insect cells, oocytes, bacteria, and yeast cells.

20 Following expression of human HG51 in a host cell, HG51 protein may be recovered to provide HG51 protein in active form. Several HG51 protein purification procedures are available and suitable for use. Recombinant HG51 protein may be purified from cell lysates and extracts by various combinations of, or individual application of salt fractionation, ion exchange chromatography, size  
25 exclusion chromatography, hydroxylapatite adsorption chromatography and hydrophobic interaction chromatography. In addition, recombinant HG51 protein can be separated from other cellular proteins by use of an immunoaffinity column made with monoclonal or polyclonal antibodies specific for full-length HG51 protein, or polypeptide fragments of HG51 protein.

30 The present invention is also directed to methods for screening for compounds which modulate the expression of DNA or RNA encoding a human HG51 protein.

The present invention relates to assays by which HG51 agonists and antagonists may be identified. Methods for identifying agonists and antagonists of

other receptors are well known in the art and can be adapted to identify agonists and antagonists of HG51. For example, Cascieri et al. (1992, *Molec. Pharmacol.* 41:1096-1099) describe a method for identifying substances that inhibit agonist binding to rat neurokinin receptors and thus are potential agonists or antagonists of neurokinin receptors. The method involves transfecting COS cells with expression vectors containing rat neurokinin receptors, allowing the transfected cells to grow for a time sufficient to allow the neurokinin receptors to be expressed, harvesting the transfected cells and resuspending the cells in assay buffer containing a known radioactively labeled agonist of the neurokinin receptors either in the presence or the absence of the substance, and then measuring the binding of the radioactively labeled known agonist of the neurokinin receptor to the neurokinin receptor. If the amount of binding of the known agonist is less in the presence of the substance than in the absence of the substance, then the substance is a potential agonist or antagonist of the neurokinin receptor.

Where binding of the substance such as an agonist or antagonist to HG51 is measured, such binding can be measured by employing a labeled substance or agonist. The substance or agonist can be labeled in any convenient manner known to the art, e.g., radioactively, fluorescently, enzymatically.

Therefore, the present invention relates to methods of expressing HG51 in recombinant systems and of identifying agonists and antagonists of HG51. The novel HG51 receptor protein of the present invention is suitable for use in an assay procedure for the identification of compounds which modulate the receptor activity. Modulating receptor activity, as described herein includes the inhibition or activation of the receptor and also includes directly or indirectly affecting the normal regulation of the receptor activity. Compounds which modulate the receptor activity include agonists, antagonists and compounds which directly or indirectly affect regulation of the receptor activity. When screening compounds in order to identify potential pharmaceuticals that specifically interact with a target receptor, it is necessary to ensure that the compounds identified are as specific as possible for the target receptor. To do this, it is necessary to screen the compounds against as wide an array as possible of receptors that are similar to the target receptor. Thus, in order to find compounds that are potential pharmaceuticals that interact with receptor A, it is necessary not only to ensure that the compounds interact with receptor A (the "plus target") and produce the desired pharmacological effect through receptor A, it is also

necessary to determine that the compounds do not interact with receptors B, C, D, etc. (the "minus targets"). In general, as part of a screening program, it is important to have as many minus targets as possible (see Hodgson, 1992, *Bio/Technology* 10:973-980, @ 980). Human HG51 proteins and the DNA molecules encoding this receptor protein have the additional utility in that they can be used as "minus targets" in screens designed to identify compounds that specifically interact with other G-protein coupled receptors.

The specificity of binding of compounds having affinity for HG51 is shown by measuring the affinity of the compounds for recombinant cells expressing the cloned receptor or for membranes from these cells. Expression of the cloned receptor and screening for compounds that bind to HG51 or that inhibit the binding of a known, radiolabeled ligand of HG51 to these cells, or membranes prepared from these cells, provides an effective method for the rapid selection of compounds with high affinity for HG51. Such ligands need not necessarily be radiolabeled but can also be nonisotopic compounds that can be used to displace bound radiolabeled compounds or that can be used as activators in functional assays. Compounds identified by the above method are likely to be agonists or antagonists of HG51 and may be peptides, proteins, or non-proteinaceous organic molecules. Compounds may modulate by increasing or attenuating the expression of DNA or RNA encoding human HG51, or by acting as an agonist or antagonist of HG51 receptor protein. These compounds that modulate the expression of DNA or RNA encoding human HG51 or the biological function thereof may be detected by a variety of assays. The assay may be a simple "yes/no" assay to determine whether there is a change in expression or function. The assay may be made quantitative by comparing the expression or function of a test sample with the levels of expression or function in a standard sample. Kits containing human HG51, antibodies to human HG51, or modified human HG51 may be prepared by known methods for such uses.

To this end, the present invention relates in part to methods of identifying a substance which modulates HG51 receptor activity, which involves:

- (a) combining a test substance in the presence and absence of a HG51 receptor protein wherein said HG51 receptor protein comprises the amino acid sequence as set forth in SEQ ID NO:2; and,
- (b) measuring and comparing the effect of the test substance in the presence and absence of the HG51 receptor protein.

In addition, several specific embodiments are disclosed herein to show the diverse type of screening or selection assay which the skilled artisan may utilize in tandem with an expression vector directing the expression of the HG51 receptor protein. Methods for identifying agonists and antagonists of other receptors are well known in the art and can be adapted to identify agonists and antagonists of HG51. Therefore, these embodiments are presented as examples and not as limitations. To this end, the present invention includes assays by which HG51 modulators (such as agonists and antagonists) may be identified. Accordingly, the present invention includes a method for determining whether a substance is a potential agonist or antagonist of HG51 that comprises:

- (a) transfecting or transforming cells with an expression vector that directs expression of HG51 in the cells, resulting in test cells;
- (b) allowing the test cells to grow for a time sufficient to allow HG51 to be expressed;
- (c) exposing the cells to a labeled ligand of HG51 in the presence and in the absence of the substance; and,
- (d) measuring the binding of the labeled ligand to HG51; where if the amount of binding of the labeled ligand is less in the presence of the substance than in the absence of the substance, then the substance is a potential agonist or antagonist of HG51.

The conditions under which step (c) of the method is practiced are conditions that are typically used in the art for the study of protein-ligand interactions: e.g., physiological pH; salt conditions such as those represented by such commonly used buffers as PBS or in tissue culture media; a temperature of about 4°C to about 55°C. The test cells may be harvested and resuspended in the presence of the substance and the labeled ligand. In a modification of the above-described method, step (c) is modified in that the cells are not harvested and resuspended but rather the radioactively labeled known agonist and the substance are contacted with the cells while the cells are attached to a substratum, e.g., tissue culture plates.

The present invention also includes a method for determining whether a substance is capable of binding to HG51, i.e., whether the substance is a potential agonist or an antagonist of HG51, where the method comprises:

- (a) transfecting or transforming cells with an expression vector that directs the expression of HG51 in the cells, resulting in test cells;

- (b) exposing the test cells to the substance; and,
- (c) measuring the amount of binding of the substance to HG51;
- (d) comparing the amount of binding of the substance to HG51 in the test cells with the amount of binding of the substance to control cells that have not been transfected with HG51;

wherein if the amount of binding of the substance is greater in the test cells as compared to the control cells, the substance is capable of binding to HG51. Determining whether the substance is actually an agonist or antagonist can then be accomplished by the use of functional assays such as, e.g., the assay involving the use of promiscuous G-proteins described below.

The conditions under which step (b) of the method is practiced are conditions that are typically used in the art for the study of protein-ligand interactions: e.g., physiological pH; salt conditions such as those represented by such commonly used buffers as PBS or in tissue culture media; a temperature of about 4°C to about 55°C. The test cells are harvested and resuspended in the presence of the substance.

Chen et al. (1995, *Analytical Biochemistry* 226: 349-354) describe a colorimetric assay which utilizes a recombinant cell transfected with an expression vector encoding a G-protein coupled receptor with a second expression vector containing a promoter with a cAMP responsive element fused to the LacZ gene. Activity of the overexpressed G-protein coupled receptor is measured as the expression and OD measurement of  $\beta$ -Gal. Therefore, another aspect of this portion of the invention includes a non-radioactive method for determining whether a substance is a potential agonist or antagonist of HG51 that comprises:

- (a) stably transfecting or transforming cells with an expression vector encoding HG51;
- (b) transiently or stably transfecting the recombinant host cell line of step (a) with an expression vector which comprises a cAMP-inducible promoter fused to a colorimetric gene such as LacZ;
- (c) allowing the transfected cells to grow for a time sufficient to allow HG51 to be expressed;
- (d) harvesting the transfected cells and resuspending the cells in the presence of a known agonist of HG51 and/or in both the presence and absence of the test compound; and,



- (e) measuring the binding of the known agonist and test compound to overexpressed HG51 by a colorimetric assay which measures expression off the cAMP-inducible promoter and comparing expression levels in the presence of the known agonist as well as in the presence and absence of the unknown substance so as to determine whether the unknown substance acts as either a potential agonist or antagonist of HG51.

Additional methods of identifying agonists or antagonists include but are by no means limited to the following:

- I. (a) transfecting or transforming cells with a first expression vector which directs expression of HG51 and a second expression vector which directs the expression of a promiscuous G-protein, resulting in test cells;
- (b) exposing the test cells to a substance that is a suspected agonist of HG51; and,
- (c) measuring the level of inositol phosphates in the cells; where an increase in the level of inositol phosphates in the cells as compared to the level of inositol phosphates in the cells in the absence of the suspected agonist indicates that the substance is an agonist of HG51.
- II. (a) transfecting or transforming cells with a first expression vector which directs expression of HG51 and a second expression vector which directs the expression of a promiscuous G-protein, resulting in test cells;
- (b) exposing the test cells to a substance that is an agonist of HG51;
- (c) subsequently or concurrently to step (b), exposing the test cells to a substance that is a suspected antagonist of HG51; and,
- (d) measuring the level of inositol phosphates in the cells; where a decrease in the level of inositol phosphates in the cells in the presence of the suspected antagonist as compared to the level of inositol phosphates in the cells in the absence of the suspected antagonist indicates that the substance is an antagonist of HG51.
- III. The method of II wherein the first and second expression vectors of step (a) are replaced with a single expression vector which expresses a chimeric HG51 protein fused at its C-terminus to a promiscuous G-protein.

The above-described methods can be modified in that, rather than exposing the test cells to the substance, membranes can be prepared from the test cells

and those membranes can be exposed to the substance. Such a modification utilizing membranes rather than cells is well known in the art and is described in, e.g., Hess et al., 1992, *Biochem. Biophys. Res. Comm.* 184:260-268. Accordingly, another embodiment of the present invention includes a method for determining whether a substance binds and/or is a potential agonist or antagonist of HG51 wherein membrane preparations from the test cells are utilized in place of the test cells. Such methods comprise the following and may utilized the physiological conditions as noted above:

- (a) transfecting or transforming cells with an expression vector that directs the expression of HG51 in the cells, resulting in test cells;
- (b) preparing membranes containing HG51 from the test cells and exposing the membranes to a ligand of HG51 under conditions such that the ligand binds to the HG51 in the membranes;
- (c) subsequently or concurrently to step (b), exposing the membranes from the test cells to a substance;
- (d) measuring the amount of binding of the ligand to the HG51 in the membranes in the presence and the absence of the substance; and,
- (e) comparing the amount of binding of the ligand to HG51 in the membranes in the presence and the absence of the substance where a decrease in the amount of binding of the ligand to HG51 in the membranes in the presence of the substance indicates that the substance is capable of binding to HG51.

The present invention also relates to a method for determining whether a substance is capable of binding to HG51 comprising:

- (a) transfecting or transforming cells with an expression vector that directs the expression of HG51 in the cells, resulting in test cells;
- (b) preparing membranes containing HG51 from the test cells and exposing the membranes from the test cells to the substance;
- (c) measuring the amount of binding of the substance to the HG51 in the membranes from the test cells; and,
- (d) comparing the amount of binding of the substance to HG51 in the membranes from the test cells with the amount of binding of the substance to membranes from control cells that have not been transfected with HG51, where if the amount of binding of the substance to HG51 in the membranes from the test cells is

greater than the amount of binding of the substance to the membranes from the control cells, then the substance is capable of binding to HG51.

Polyclonal or monoclonal antibodies may be raised against human HG51 or a synthetic peptide (usually from about 9 to about 25 amino acids in length) from a portion of human HG51 as disclosed in SEQ ID NO:2. Monospecific antibodies to human HG51 are purified from mammalian antisera containing antibodies reactive against human HG51 or are prepared as monoclonal antibodies reactive with human HG51 using the technique of Kohler and Milstein (1975, *Nature* 256: 495-497). Monospecific antibody as used herein is defined as a single antibody species or multiple antibody species with homogenous binding characteristics for human HG51. Homogenous binding as used herein refers to the ability of the antibody species to bind to a specific antigen or epitope, such as those associated with human HG51, as described above. Human HG51-specific antibodies are raised by immunizing animals such as mice, rats, guinea pigs, rabbits, goats, horses and the like, with an appropriate concentration of human HG51 protein or a synthetic peptide generated from a portion of human HG51 with or without an immune adjuvant.

Preimmune serum is collected prior to the first immunization. Each animal receives between about 0.1 mg and about 1000 mg of human HG51 protein associated with an acceptable immune adjuvant. Such acceptable adjuvants include, but are not limited to, Freund's complete, Freund's incomplete, alum-precipitate, water in oil emulsion containing *Corynebacterium parvum* and tRNA. The initial immunization consists of human HG51 protein or peptide fragment thereof in, preferably, Freund's complete adjuvant at multiple sites either subcutaneously (SC), intraperitoneally (IP) or both. Each animal is bled at regular intervals, preferably weekly, to determine antibody titer. The animals may or may not receive booster injections following the initial immunization. Those animals receiving booster injections are generally given an equal amount of human HG51 in Freund's incomplete adjuvant by the same route. Booster injections are given at about three week intervals until maximal titers are obtained. At about 7 days after each booster immunization or about weekly after a single immunization, the animals are bled, the serum collected, and aliquots are stored at about -20°C.

Monoclonal antibodies (mAb) reactive with human HG51 are prepared by immunizing inbred mice, preferably Balb/c, with human HG51 protein. The mice are immunized by the IP or SC route with about 1 mg to about 100 mg, preferably

- about 10 mg, of human HG51 protein in about 0.5 ml buffer or saline incorporated in an equal volume of an acceptable adjuvant, as discussed above. Freund's complete adjuvant is preferred. The mice receive an initial immunization on day 0 and are rested for about 3 to about 30 weeks. Immunized mice are given one or more booster
- 5 immunizations of about 1 to about 100 mg of human HG51 in a buffer solution such as phosphate buffered saline by the intravenous (IV) route. Lymphocytes, from antibody positive mice, preferably splenic lymphocytes, are obtained by removing spleens from immunized mice by standard procedures known in the art. Hybridoma cells are produced by mixing the splenic lymphocytes with an appropriate fusion
- 10 partner, preferably myeloma cells, under conditions which will allow the formation of stable hybridomas. Fusion partners may include, but are not limited to: mouse myelomas P3/NS1/Ag 4-1; MPC-11; S-194 and Sp 2/0, with Sp 2/0 being preferred. The antibody producing cells and myeloma cells are fused in polyethylene glycol, about 1000 mol. wt., at concentrations from about 30% to about 50%. Fused
- 15 hybridoma cells are selected by growth in hypoxanthine, thymidine and aminopterin supplemented Dulbecco's Modified Eagles Medium (DMEM) by procedures known in the art. Supernatant fluids are collected from growth positive wells on about days 14, 18, and 21 and are screened for antibody production by an immunoassay such as solid phase immunoradioassay (SPIRA) using human HG51 as the antigen. The
- 20 culture fluids are also tested in the Ouchterlony precipitation assay to determine the isotype of the mAb. Hybridoma cells from antibody positive wells are cloned by a technique such as the soft agar technique of MacPherson, 1973, Soft Agar Techniques, in *Tissue Culture Methods and Applications*, Kruse and Paterson, Eds., Academic Press.
- 25 Monoclonal antibodies are produced *in vivo* by injection of pristine primed Balb/c mice, approximately 0.5 ml per mouse, with about  $2 \times 10^6$  to about  $6 \times 10^6$  hybridoma cells about 4 days after priming. Ascites fluid is collected at approximately 8-12 days after cell transfer and the monoclonal antibodies are purified by techniques known in the art.
- 30 *In vitro* production of anti-human HG51 mAb is carried out by growing the hybridoma in DMEM containing about 2% fetal calf serum to obtain sufficient quantities of the specific mAb. The mAb are purified by techniques known in the art.

Antibody titers of ascites or hybridoma culture fluids are determined by various serological or immunological assays which include, but are not limited to, precipitation, passive agglutination, enzyme-linked immunosorbent antibody (ELISA) technique and radioimmunoassay (RIA) techniques. Similar assays are used to detect  
5 the presence of human HG51 in body fluids or tissue and cell extracts.

It is readily apparent to those skilled in the art that the above described methods for producing monospecific antibodies may be utilized to produce antibodies specific for human HG51 peptide fragments, or full-length human HG51.

Human HG51 antibody affinity columns are made, for example, by  
10 adding the antibodies to Affigel-10 (Biorad), a gel support which is pre-activated with N-hydroxysuccinimide esters such that the antibodies form covalent linkages with the agarose gel bead support. The antibodies are then coupled to the gel via amide bonds with the spacer arm. The remaining activated esters are then quenched with 1M  
15 ethanolamine HCl (pH 8). The column is washed with water followed by 0.23 M glycine HCl (pH 2.6) to remove any non-conjugated antibody or extraneous protein. The column is then equilibrated in phosphate buffered saline (pH 7.3) and the cell culture supernatants or cell extracts containing full-length human HG51 or human  
20 HG51 protein fragments are slowly passed through the column. The column is then washed with phosphate buffered saline until the optical density ( $A_{280}$ ) falls to background, then the protein is eluted with 0.23 M glycine-HCl (pH 2.6). The purified human HG51 protein is then dialyzed against phosphate buffered saline.

The specificity of binding of compounds showing affinity for HG51 is shown by measuring the affinity of the compounds for recombinant cells expressing the cloned receptor or for membranes from these cells. Expression of the cloned  
25 receptor and screening for compounds that bind to HG51 or that inhibit the binding of a known, radiolabeled ligand of HG51 to these cells, or membranes prepared from these cells, provides an effective method for the rapid selection of compounds with high affinity for HG51. Such ligands need not necessarily be radiolabeled but can also be nonisotopic compounds that can be used to displace bound radiolabeled  
30 compounds or that can be used as activators in functional assays. Compounds identified by the above method are likely to be agonists or antagonists of HG51 and may be peptides, proteins, or non-proteinaceous organic molecules.

As a further modification of the above-described methods, RNA encoding HG51 can be prepared as, *e.g.*, by *in vitro* transcription using a plasmid

containing HG51 under the control of a bacteriophage T7 promoter, and the RNA can be microinjected into *Xenopus* oocytes in order to cause the expression of HG51 in the oocytes. Substances are then tested for binding to the HG51 expressed in the oocytes. Alternatively, rather than detecting binding, the effect of the substances on the electrophysiological properties of the oocytes can be determined.

The present invention includes assays by which HG51 agonists and antagonists may be identified by their ability to stimulate or antagonize a functional response mediated by HG51. HG51 belongs to the class of proteins known as G-protein coupled receptors (GPCRs). GPCRs transmit signals across cell membranes upon the binding of ligand. The ligand-bound GPCR interacts with a heterotrimeric G-protein, causing the  $G\alpha$  subunit of the G-protein to disassociate from the  $G\beta$  and  $G\gamma$  subunits. The  $G\alpha$  subunit can then go on to activate a variety of second messenger systems.

Generally, a particular GPCR is only coupled to a particular type of G-protein. Thus, to observe a functional response from the GPCR, it is necessary to ensure that the proper G-protein is present in the system containing the GPCR. It has been found, however, that there are certain G-proteins that are "promiscuous." These promiscuous G-proteins will couple to, and thus transduce a functional signal from, virtually any GPCR. See Offermanns & Simon, 1995, *J. Biol. Chem.* 270:15175-15180. These authors describe a system in which cells are transfected with expression vectors that result in the expression of one of a large number of GPCRs as well as the expression of one of the promiscuous G-proteins  $G\alpha 15$  or  $G\alpha 16$ . Upon the addition of an agonist of the GPCR to the transfected cells, the GPCR was activated and was able, via  $G\alpha 15$  or  $G\alpha 16$ , to activate the  $\beta$  isoform of phospholipase C, leading to an increase in inositol phosphate levels in the cells. Therefore, by making use of these promiscuous G-proteins as in Offermanns and Simon, *supra*, it is possible to set up functional assays for HG51, even in the absence of knowledge of the G-protein with which HG51 is coupled *in vivo*. One possibility is to create a fusion or chimeric protein composed of the extracellular and membrane spanning portion of HG51 fused to a promiscuous G-protein. Such a fusion protein would be expected to transduce a signal following binding of ligand to the HG51 portion of the fusion protein. Accordingly, the present invention provides a method of identifying antagonists of HG51 comprising:

- (a) providing cells that expresses a chimeric HG51 protein fused at its C-terminus to a promiscuous G-protein;
- (b) exposing the cells to an agonist of HG51;
- (c) subsequently or concurrently to step (b), exposing the cells to a substance that is a suspected antagonist of HG51; and,
- (d) measuring the level of inositol phosphates in the cells; where a decrease in the level of inositol phosphates in the cells in the presence of the substance as compared to the level of inositol phosphates in the cells in the absence of the substance indicates that the substance is an antagonist of HG51.

Another possibility for utilizing promiscuous G-proteins in connection with HG51 includes a method of identifying agonists of HG51 comprising:

- (a) providing cells that expresses both HG51 and a promiscuous G-protein;
- (b) exposing the cells to a substance that is a suspected agonist of HG51; and,
- (c) measuring the level of inositol phosphates in the cells; where an increase in the level of inositol phosphates in the cells as compared to the level of inositol phosphates in the cells in the absence of the suspected agonist indicates that the substance is an agonist of HG51.

Levels of inositol phosphates can be measured by monitoring calcium mobilization. Intracellular calcium mobilization is typically assayed in whole cells under a microscope using fluorescent dyes or in cell suspensions via luminescence using the aequorin assay.

In a particular embodiment of the above-described method, the cells are transfected with expression vectors that direct the expression of HG51 and the promiscuous G-protein in the cells.

The conditions under which step (b) of the method is practiced are conditions that are typically used in the art for the study of protein-ligand interactions: *e.g.*, physiological pH; salt conditions such as those represented by such commonly used buffers as PBS or in tissue culture media; a temperature of about 4°C to about 55°C.

In a particular embodiment of the above-described method, the promiscuous G-protein is selected from the group consisting of Gα15 or Gα16. Expression vectors containing Gα15 or Gα16 are known in the art. See, *e.g.*,

Offermanns; Buhl *et al.*, 1993, *FEBS Lett.* 323:132-134; Amatruda *et al.*, 1993, *J. Biol. Chem.* 268:10139-10144.

The above-described assay can be easily modified to form a method to identify antagonists of HG51. Such a method is also part of the present invention and  
5 comprises:

- (a) providing cells that expresses both HG51 and a promiscuous G-protein;
- (b) exposing the cells to a substance that is an agonist of HG51;
- (c) subsequently or concurrently to step (b), exposing the cells to a  
10 substance that is a suspected antagonist of HG51; and,
- (d) measuring the level of inositol phosphates in the cells; where a decrease in the level of inositol phosphates in the cells in the presence of the suspected antagonist as compared to the level of inositol phosphates in the cells in the absence of the suspected antagonist indicates that the substance is an antagonist of  
15 HG51.

The conditions under which steps (b) and (c) of the method are practiced are conditions that are typically used in the art for the study of protein-ligand interactions: *e.g.*, physiological pH; salt conditions such as those represented by such commonly used buffers as PBS or in tissue culture media; a temperature of  
20 about 4°C to about 55°C.

In a particular embodiment of the above-described method, the cells are transfected with expression vectors that direct the expression of HG51 and the promiscuous G-protein in the cells.

In a particular embodiment of the above-described method, the  
25 promiscuous G-protein is selected from the group consisting of G $\alpha$ 15 or G $\alpha$ 16.

Agonists and antagonists of HG51 that are identified by the above-described methods should have utility in the treatment of diseases that involve the inappropriate expression of HG51. In particular, given the expression pattern of HG51 (see Figure 4), such agonists and antagonists should have utility in the  
30 treatment of various disorders including but not limited to obesity, type II diabetes, as well as various GI diseases such as inflammatory bowel disease, constipation and diarrhea.

The DNA of the present invention, or hybridization probes based upon the DNA, can be used in chromosomal mapping studies in order to identify the



chromosomal locations of the HG51 gene or of genes encoding proteins related to HG51. Such mapping studies can be carried out using well-known genetic and/or chromosomal mapping techniques such as, *e.g.*, linkage analysis with respect to known chromosomal markers or *in situ* hybridization. See, *e.g.*, Verma et al., 1988, 5 Human Chromosomes: A Manual of Basic Techniques, Pergamon Press, New York, NY. After identifying the chromosomal location of the HG51 gene or genes encoding proteins related to HG51, this information can be compared with the locations of known disease-causing genes contained in genetic map data (such as the data found in 10 the Genome Issue of Science, 1994, 265:1981-2144). In this way, one can correlate the chromosomal location of the HG51 gene or of genes encoding proteins related to HG51 with the locations of known disease-causing genes and thus help to limit the region of DNA containing such disease-causing genes. This will simplify the process of cloning such disease-causing genes. Also, once linkage between the chromosomal 15 location of the HG51 gene or of genes encoding proteins related to HG51 and the locations of a known disease-causing gene is established, that linkage can be used diagnostically to identify restriction fragment length polymorphisms (RFLPs) in the vicinity of the HG51 gene or of genes encoding proteins related to HG51. Such RFLPs will be associated with the disease-causing gene and thus can be used to identify individuals carrying the disease-causing gene.

20 For such chromosomal mapping studies as described herein, it may be advantageous to use, in addition to the DNA of the present invention, the reverse complement of the DNA of the present invention or RNA corresponding to the DNA of the present invention.

Gene therapy may be used to introduce HG51 polypeptides into the 25 cells of target organs. Nucleotides encoding HG51 polypeptides can be ligated into viral vectors which mediate transfer of the nucleotides by infection of recipient cells. Suitable viral vectors include retrovirus, adenovirus, adeno-associated virus, herpes virus, vaccinia virus, and polio virus based vectors. Alternatively, nucleotides encoding HG51 polypeptides can be transferred into cells for gene therapy by non- 30 viral techniques including receptor-mediated targeted transfer using ligand-nucleotide conjugates, lipofection, membrane fusion, or direct microinjection. These procedures and variations thereof are suitable for *ex vivo* as well as *in vivo* gene therapy. Gene therapy with HG51 polypeptides will be particularly useful for the treatment of diseases where it is beneficial to elevate HG51 activity.

PCR reactions can be carried out with a variety of thermostable enzymes including but not limited to AmpliTaq, AmpliTaq Gold, or Vent polymerase. For AmpliTaq, reactions can be carried out in 10 mM Tris-Cl, pH 8.3, 2.0 mM MgCl<sub>2</sub>, 200  $\mu$ M for each dNTP, 50 mM KCl, 0.2  $\mu$ M for each primer, 10 ng of DNA  
5 template, 0.05 units/ $\mu$ l of AmpliTaq. The reactions are heated at 95°C for 3 minutes and then cycled 35 times using the cycling parameters of 95°C, 20 seconds, 62°C, 20 seconds, 72°C, 3 minutes. In addition to these conditions, a variety of suitable PCR protocols can be found in PCR Primer, A Laboratory Manual, edited by C.W. Dieffenbach and G.S. Dveksler, 1995, Cold Spring Harbor Laboratory Press; or PCR  
10 Protocols: A Guide to Methods and Applications, Michael *et al.*, eds., 1990, Academic Press.

The assays described above can be carried out with cells that have been transiently or stably transfected or stably transformed with expression vectors which encode HG51. Transfection is meant to include any method known in the art  
15 for introducing HG51 into the test cells. For example, transfection includes calcium phosphate or calcium chloride mediated transfection, lipofection, infection with a retroviral construct containing HG51, and electroporation. Transformation is meant to encompass a genetic change to the target cell resulting from an incorporation of DNA.

20 The DNA molecules, RNA molecules, recombinant protein and antibodies of the present invention may be used to screen and measure levels of human HG51. The recombinant proteins, DNA molecules, RNA molecules and antibodies lend themselves to the formulation of kits suitable for the detection and typing of human HG51. Such a kit would comprise a compartmentalized carrier  
25 suitable to hold in close confinement at least one container. The carrier would further comprise reagents such as recombinant HG51 or anti-HG51 antibodies suitable for detecting human HG51. The carrier may also contain a means for detection such as labeled antigen or enzyme substrates or the like.

30 Pharmaceutically useful compositions comprising modulators of human HG51 may be formulated according to known methods such as by the admixture of a pharmaceutically acceptable carrier. Examples of such carriers and methods of formulation may be found in Remington's Pharmaceutical Sciences. To form a pharmaceutically acceptable composition suitable for effective administration, such compositions will contain an effective amount of the protein, DNA, RNA,

modified human HG51, or either HG51 agonists or antagonists including tyrosine kinase activators or inhibitors.

Therapeutic or diagnostic compositions of the invention are administered to an individual in amounts sufficient to treat or diagnose disorders.

- 5 The effective amount may vary according to a variety of factors such as the individual's condition, weight, sex and age. Other factors include the mode of administration.

The pharmaceutical compositions may be provided to the individual by a variety of routes such as subcutaneous, topical, oral and intramuscular.

- 10 The term "chemical derivative" describes a molecule that contains additional chemical moieties which are not normally a part of the base molecule. Such moieties may improve the solubility, half-life, absorption, etc. of the base molecule. Alternatively the moieties may attenuate undesirable side effects of the base molecule or decrease the toxicity of the base molecule. Examples of such  
15 moieties are described in a variety of texts, such as Remington's Pharmaceutical Sciences.

Compounds identified according to the methods disclosed herein may be used alone at appropriate dosages. Alternatively, co-administration or sequential administration of other agents may be desirable.

- 20 The present invention also has the objective of providing suitable topical, oral, systemic and parenteral pharmaceutical formulations for use in the novel methods of treatment of the present invention. The compositions containing compounds identified according to this invention as the active ingredient can be administered in a wide variety of therapeutic dosage forms in conventional vehicles  
25 for administration. For example, the compounds can be administered in such oral dosage forms as tablets, capsules (each including timed release and sustained release formulations), pills, powders, granules, elixirs, tinctures, solutions, suspensions, syrups and emulsions, or by injection. Likewise, they may also be administered in intravenous (both bolus and infusion), intraperitoneal, subcutaneous, topical with or  
30 without occlusion, or intramuscular form, all using forms well known to those of ordinary skill in the pharmaceutical arts.

Advantageously, compounds of the present invention may be administered in a single daily dose, or the total daily dosage may be administered in divided doses of two, three or four times daily. Furthermore, compounds for the

present invention can be administered in intranasal form via topical use of suitable intranasal vehicles, or via transdermal routes, using those forms of transdermal skin patches well known to those of ordinary skill in that art. To be administered in the form of a transdermal delivery system, the dosage administration will, of course, be continuous rather than intermittent throughout the dosage regimen.

For combination treatment with more than one active agent, where the active agents are in separate dosage formulations, the active agents can be administered concurrently, or they each can be administered at separately staggered times.

The dosage regimen utilizing the compounds of the present invention is selected in accordance with a variety of factors including type, species, age, weight, sex and medical condition of the patient; the severity of the condition to be treated; the route of administration; the renal, hepatic and cardiovascular function of the patient; and the particular compound thereof employed. A physician or veterinarian of ordinary skill can readily determine and prescribe the effective amount of the drug required to prevent, counter or arrest the progress of the condition. Optimal precision in achieving concentrations of drug within the range that yields efficacy without toxicity requires a regimen based on the kinetics of the drug's availability to target sites. This involves a consideration of the distribution, equilibrium, and elimination of a drug.

The following examples are provided to illustrate the present invention without, however, limiting the same hereto.

#### EXAMPLE 1

##### Isolation and Characterization of DNA Fragments Encoding HG51

The full-length coding sequence of HG51 was isolated using a modified method called RCCA (Liu *et al.*, *Gene* 207 (1998) 1-7; McDonald *et al.*, *BBRC* 247 (1998) 266-270). An EST was identified as a putative G protein coupled receptor and was designated HG51-EST.

HG51-EST: GenBank Acc. #: AA745052

EST Id: 1460712; EST name: np72h03.s1;

GenBank gi: 2783816; Clone Id: IMAGE :1131893 (3'):

TAAGTCAGTA GCATAAAAC ATGAGCAAGT ACATCTAATC ACATCTGAGA ATACTAAAAT  
 GGATGTGTGG TTTTCATTTCT GCATTTCATC TTAGCAGTAA ATGTCAAAAT GCATCATATA  
 TGCATTTGTG ACTGGAATC TTCTCGAAGA GGCTGCCGCT AAACCCGTCC CACACGCAGC  
 CCACGGTGTC CCACACCCAG CCGTTCCTCA GGCAGGACAC GAAGGTAAAG GTGACCCCGA  
 5 AGAGGTACAC AGCAGGTCGC TGAGGCTGAT GTTGACCAGG AGGAGGTGAG TGGGAGTGCG  
 GAGCGCTGGA ACTTGTAGTA GAGGACGAGC ACCAGCAGGT TGTGCGCGAC GCCCAGCAGC  
 CCAATGGAGC CCAGCAGCAG CGCAGGCCCT CGTGC (SEQ ID NO:3).

The above EST may also be viewed at the National Center for Biotechnology Information (NCBI) homepage at <http://www.ncbi.nlm.nih.gov/>.

10 Four primers HG51.F39, HG51.F51, HG51.R121 and HG51.R179  
 were designed from the EST sequence. Primer pairs HG51.F39 + HG51.R121 and  
 HG51.F51 + HG51.R179 were screened by PCR against cDNA libraries of placenta,  
 prostate, testis, and fetal brain. The fetal brain and testis cDNA libraries was chosen  
 for attempts to clone the full-length sequence of HG51. PCR reactions using Primers  
 15 HG51.F51 and HG51.R179 were carried out on the fetal brain and testis cDNA  
 libraries with  $\geq 2.5$  kb inserts. Positive wells were identified and RCCA was then  
 performed on these wells with the following primer combinations HG51.F39 +  
 PBS.543R or PBS.873F and HG51.R179 + PBS.543R or PBS.873F. PCR products  
 were then purified, sequenced, and assembled to the contig. HG51.F51 + HG51.R179  
 20 primers were the used to screen the fetal brain 1-2.5kb and placental 1-2.5kb plasmid  
 libraries. Positive wells were identified and RCCA was performed on these wells  
 using the following primers combinations HG51.F51 + PBS.543R or PBS.873F and  
 HG51.R179 + PBS.543R or PBS.873F in the primary reaction and in the secondary  
 reaction nested primers HG51.F51 + PBS.578R or PBS.838F and HG51.R121 +  
 25 PBS.578R or PBS.838F were used. Products were then purified, sequenced, and  
 assembled to the contig. RCCA using the primer combinations above was then  
 performed on new pools and products were purified and sequenced. An open reading  
 frame of 1209 base pairs and encoding 402 amino acids was identified. Finally, the  
 full length gene was amplified by semi-nested PCR reactions using primers  
 30 HG51.KpnI + HG51.NotI1283R and HG51.KpnI + HG51.NotI1225R, and the  
 product containing the sequence from HG51.KpnI to HG51.NotI1225 was cloned into  
 pcDNA3.1.

The oligonucleotide primers utilized as described above are as follows:

HG51.KpnI: CGGGTACCATGTACTCGGGGAACCGCA (SEQ ID NO:4);

HG51.NotI1283R GCGCGGCCGCGACGGGTATTCCAGACACTTC (SEQ ID NO:5);  
 HG51.NotI1225R GCGCGGCCGCCCCATCTTTCGTTGCCATTC (SEQ ID NO:6);  
 HG51.F51 CAACAACCTGCTGGTGCTCGTC (SEQ ID NO:7);  
 HG51.F39 GCTGGGCGTCGGCAACAA (SEQ ID NO:8);  
 5 HG51.R179 CAGGCAGGACACGAAGGTAA (SEQ ID NO:9);  
 HG51.R121 GGTGCTGAGGCTGATGTTGAC (SEQ ID NO:10);  
 PBS.543R GGGGATGTGCTGCAAGGCGA (SEQ ID NO:11);  
 PBS.578R CCAGGGTTTTCCAGTCACGAC (SEQ ID NO:12);  
 PBS.873F CCCAGGCTTTACACTTTATGCTTCC (SEQ ID NO:13);  
 10 PBS.838F TTGTGTGGAATTGTGAGCGGATAAC (SEQ ID NO:14).

The full length human HG51 cDNA disclosed herein as SEQ ID NO:1 is 1536 bp,  
 with an open reading frame from nucleotide 160 to nucleotide 1365, with a "TAG"  
 termination codon from nucleotides 1366-1368. This open reading frame encodes a  
 human HG51 GPCR, which shares homology to human rhodopsin. The HG51  
 15 protein contains an open reading frame of 402 amino acids in length, as shown in  
 Figure 2 and as set forth in SEQ ID NO:2. Figures 3A, 3B and 3C show the  
 translation of the HG51 open reading frame. The nucleotide sequence shown is as set  
 forth in SEQ ID NO:1. The amino acid sequence shown is as set forth in SEQ ID  
 NO: 2.

20

## EXAMPLE 2

### Northern Analysis of Human HG51 Gene Expression

Human multi-tissue Northern blots were purchased from Clontech  
 25 (Palo Alto, CA, USA). The entire coding region of HG51 was labeled with <sup>32</sup>P-  
 dCTP using the Redy-Prime Kit of Amersham (Amersham, USA). Hybridizations  
 and washing of filters were carried out under stringent conditions following the  
 protocols of the Northern blot supplier (Clontech, Inc.). The blots were exposed to X-  
 ray film by autoradiography for 5 days at -80°C with an intensifying screen.  
 30 Northern analysis of multi-tissue mRNA blots showed that HG51 was weakly  
 expressed in many tissues as transcripts of ~9.0 kb and ~2.5 kb. This data is  
 presented in Figures 4A - 4E. Also, expression of HG51 in HEK293 cells led to the  
 increase in intracellular cAMP level, indicating that HG51 is coupled to the Gs  
 protein.

The present invention is not to be limited in scope by the specific embodiments described herein. Indeed, various modifications of the invention in addition to those described herein will become apparent to those skilled in the art from the foregoing description. Such modifications are intended to fall within the  
5 scope of the appended claims.

Various publications are cited herein, the disclosures of which are incorporated by reference in their entireties.

## WHAT IS CLAIMED:

1. A purified DNA molecule encoding HG51 which comprises the nucleotide sequence:  
GGGGCCACGG GGGGTGCGCC GGC GCGCGGT AGCGCGGGCC CCTCAGTGCA CAATGGCCAG  
5 AGCAGGCGGC GGAGCCCCAG CCCACCCAG TCGGAGCGC GCCGCGAGCC CCGCCGCAAG  
CTGAGCGCCT CCGCCCGCCA GCGCGCGCGG CGCCGGGCCA TGTACTCGGG GAACCGCAGC  
GGCGGCCACG GCTACTGGGA CGGCGGCGGG GCCGCGGGCG CTGAGGGGCC GGC GCGCGCG  
GGGACACTGA GCGCCGCGCC CCTCTTCAGC CCCGGCACCT ACGAGCGCCT GGC GCTGCTG  
CTGGGCTCCA TTGGGCTGCT GGGCGTCGGC AACAACTGC TGGTGCTCGT CCTCTACTAC  
10 AAGTTCCAGC GGCTCCGCAC TCCACTCAC CTCCTCCTGG TCAACATCAG CCTCAGCGAC  
CTGCTGGTGT CCCTCTTCGG GGTACCTTT ACCTTCGTGT CTGCCTGAG GAACGGCTGG  
GTGTGGGACA CCGTGGGCTG CGTGTGGGAC GGGTTTAGCG GCAGCCTCT CGGGATTGTT  
TCCATTGCCA CCCTAACCGT GCTGGCCTAT GAACGTTACA TTCGCGTGGT CCATGCCAGA  
GTGATCAATT TTTCTGGGC CTGGAGGGCC ATTACCTACA TCTGGCTCTA CTCACTGGCG  
15 TGGGCAGGAG CACCTCTCCT GGGATGGAAC AGGTACATCC TGGACGTACA CGGACTAGGC  
TGCCTGTGG ACTGGAATC CAAGGATGCC AACGATTCCT CCTTTGTGCT TTTCTTATTT  
CTTGGCTGCC TGGTGGTGCC CCTGGGTGTC ATAGCCCATT GCTATGGCCA TATTCTATAT  
TCCATTGAA TGCTTCGTTG TGTGGAAGAT CTTAGACAA TTCAAGTGAT CAAGATTTTA  
AAATATGAAA AGAACTGGC CAAAATGTGC TTTTAAATGA TATTCACCTT CCTGGTCTGT  
20 TGGATGCCTT ATATCGTGAT CTGCTTCTTG GTGGTTAATG GTCATGGTCA CCTGGTCACT  
CCAACAATAT CTATTGTTTC GTACCTCTTT GCTAAATCGA AACTGTATA CAATCCAGTG  
ATTTATGTCT TCATGATCAG AAAGTTTCGA AGATCCCTTT TGCAGCTTCT GTGCCTCCGA  
CTGCTGAGGT GCCAGAGGCC TGCTAAAGAC CTACCAGCAG CTGGAAGTGA AATGCAGATC  
AGACCCATTG TGATGTCACA GAAAGATGGG GACAGGCCAA AGAAAAAGT GACTTTCAAC  
25 TCTTCTTCCA TCATTTTAT CATCACCAGT GATGAATCAC TGTCAGTTGA CGACAGCGAC  
AAAACCAATG GTCCAAAGT TGATGTAATC CAAGTTCGTC CTTTGTAGGA ATGAAGAATG  
GCAACGAAAG ATGGGGCCTT AAATGGGATG CCACTTTGG ACTTTCATCA TAAGAAGTGT  
CTGGAATACC CGTCTATGT AATATCAACA GAACCTTGTG GTCCAGCAGG AAATCCGAAT  
TGCCCATATG CTCTGGGCC TCAGGAAGAG GTTGAAC , disclosed herein as SEQ ID  
30 NO:1.
2. A purified DNA molecule encoding human HG51 wherein said DNA molecule encodes a protein comprising the amino acid sequence:



MYSGNRSGGH GYWDGGGAAG AEGPAPAGTL SPAPLFSPGT YERLALLLGS IGLLGVGNNL  
 LVLVLYYKFQ RLRTPTHLLL VNISLSDLLV SLFGVTTFV SCLRNGVWWD TVGCVWDGFS  
 GSLFGIVSIA TLTVLAYERI IRVVHARVIN FSWAWRAITY IWLYSLAWAG APLLGNRYI  
 LDVHGLGCTV DWKSKDANDS SFVLFLFLGC LVVPLGVIAH CYGHILYSIR MLRCVEDLQT  
 5 IQVIKILKYE KKLAKMCFLM IFTFLVCWMP YIVICFLVN GHGHLVTPTI SIVSYLFAKS  
 NTVYNPVIYV FMIRKFRSL LQLLCLRLLR CQPAKDLPA AGSEMQRPI VMSQKDGRP  
 KKKVTFNSSS IIFIITSDES LSVDDSDKTN GSKVDVIQVR PL , which is disclosed herein  
 in the three letter amino acid code as set forth in SEQ ID NO:2.

- 10                   3.     An expression vector for the expression of a HG51 protein in a  
                       recombinant host cell wherein said expression vector comprises a DNA molecule  
                       which encodes the amino acid sequence of claim 2.
4.     An expression vector of claim 3 which is a eukaryotic
- 15   expression vector.
5.     An expression vector of claim 3 which is a prokaryotic
- expression vector.
- 20                   6.     A host cell which expresses a recombinant HG51 protein  
                       wherein said host cell contains the expression vector of claim 3.
7.     A host cell which expresses a recombinant HG51 protein  
                       wherein said host cell contains the expression vector of claim 4.
- 25                   8.     A host cell which expresses a recombinant HG51 protein  
                       wherein said host cell contains the expression vector of claim 5.
9.     A subcellular membrane fraction obtained from the host cell of
- 30   claim 6 which contains recombinant HG51.
10.    A subcellular membrane fraction obtained from the host cell of
- claim 7 which contains recombinant HG51.

11. A subcellular membrane fraction obtained from the host cell of claim 8 which contains recombinant HG51.

12. A purified DNA molecule encoding HG51 which consists of the nucleotide sequence:

5 GGGGCCACGG GGGGTGCGCC GGC GCGCGGT AGCGCGGGCC CCTCAGTGCA CAATGGCCAG  
AGCAGGCGGC GGAGCCCCAG CCCCACCCAG TCGGAGCGC GCCGCGAGCC CCGCCGCAAG  
CTGAGCGCCT CCGCCCGCCA GGC GCGCGCGG CGCCGGGCCA TG TACTCGGG GAACCGCAGC  
GGCGGCCACG GCTACTGGGA CGGCGGCGGG GCCGCGGGCG CTGAGGGGCC GGCGCCGGCG  
10 GGGACACTGA GCCCCGCGCC CCTCTTCAGC CCCGGCACCT ACGAGCGCCT GGCGCTGCTG  
CTGGGCTCCA TTGGGCTGCT GGGCGTCGGC AACAACTGC TGGTGCTCGT CCTCTACTAC  
AAGTTCCAGC GGCTCCGCAC TCCCACTCAC CTCCTCCTGG TCAACATCAG CCTCAGCGAC  
CTGCTGGTGT CCCTCTTCGG GGTACCTTT ACCTTCGTGT CCTGCCTGAG GAACGGCTGG  
GTGTGGGACA CCGTGGGCTG CGTGTGGGAC GGGTTTAGCG GCAGCCTCTT CGGGATTGTT  
15 TCCATTGCCA CCCTAACCGT GCTGGCCTAT GAACGTTACA TTCGCGTGGT CCATGCCAGA  
GTGATCAATT TTTCTGGGC CTGGAGGGCC ATTACCTACA TCTGGCTCTA CTACTGGCG  
TGGGCAGGAG CACCTCTCCT GGGATGGAAC AGGTACATCC TGGACGTACA CGGACTAGGC  
TGCACTGTGG ACTGGAAATC CAAGGATGCC AACGATTCCT CCTTTGTGCT TTTCTTATTT  
CTTGGCTGCC TGGTGGTGCC CCTGGGTGTC ATAGCCCAT T GCTATGGCCA TATTCTATAT  
20 TCCATTGAA TGCTTCGTTG TGTGGAAGAT CTTCAGACAA TTCAAGTGAT CAAGATTTTA  
AAATATGAAA AGAACTGGC CAAAATGTGC TTTTAAATGA TATTCACCTT CCTGGTCTGT  
TGGATGCCTT ATATCGTGAT CTGCTTCTTG GTGGTTAATG GTCATGGTCA CCTGGTCACT  
CCAACAATAT CTATTGTTTC GTACCTCTTT GCTAAATCGA ACACTGTATA CAATCCAGTG  
ATTTATGTCT TCATGATCAG AAAGTTTCGA AGATCCCTTT TGCAGCTTCT GTGCCTCCGA  
25 CTGCTGAGGT GCCAGAGGCC TGCTAAAGAC CTACCAGCAG CTGGAAGTGA AATGCAGATC  
AGACCCATTG TGATGTCACA GAAAGATGGG GACAGGCCAA AGAAAAAGT GACTTTCAAC  
TCTTCTTCCA TCATTTTAT CATCACCAGT GATGAATCAC TGTCAGTTGA CGACAGCGAC  
AAAACCAATG GGTCCAAAGT TGATGTAATC CAAGTTCGTC CTTGTAGGA ATGAAGAATG  
GCAACGAAAG ATGGGGCCTT AAATTGGATG CCACTTTTGG ACTTTCATCA TAAGAAGTGT  
30 CTGGAATACC CGTTCTATGT AATATCAACA GAACCTTG TGCCAGCAGG AAATCCGAAT  
TGCCCATATG CTCTGGGCC TCAGGAAGAG GTTGAAC , disclosed herein as SEQ ID  
NO:1.

13. The purified DNA molecule of claim 12 which consists of a nucleotide sequence from nucleotide 160 to nucleotide 1368 of SEQ ID NO:1.
14. An expression vector for the expression of a HG51 protein in a recombinant host cell wherein said expression vector comprises a DNA molecule of claim 13.
15. An expression vector of claim 14 which is a eukaryotic expression vector.
16. An expression vector of claim 14 which is a prokaryotic expression vector.
17. A host cell which expresses a recombinant HG51 protein wherein said host cell contains the expression vector of claim 14.
18. A host cell which expresses a recombinant HG51 protein wherein said host cell contains the expression vector of claim 15.
19. A host cell which expresses a recombinant HG51 protein wherein said host cell contains the expression vector of claim 16.
20. A subcellular membrane fraction obtained from the host cell of claim 17 which contains recombinant HG51 protein.
21. A subcellular membrane fraction obtained from the host cell of claim 18 which contains recombinant HG51 protein.
22. A subcellular membrane fraction obtained from the host cell of claim 19 which contains recombinant HG51 protein.
23. A purified HG51 protein which comprises the amino acid sequence:

MYSGNRSGGH GYWDGGGAAG AEGPAPAGTL SPAPLFSPGT YERLALLLGS IGLLGVGNNL  
 LVLVLYYKFQ RLRTPTHLLV VNISLSDLLV SLFGVTFTFV SCLRNGWVWD TVGCVWDGFS  
 GSLEFIVSIA TLTVLAYERY IRVVHARVIN FSWAWRAITY IWLYSLAWAG APLLGWNRYYI  
 LDVHGLGCTV DWKSKDANDS SFVLFLFLGC LVPPLGVIAH CYGHILYSIR MLRCVEDLQT  
 5 IQVIKILKYE KKLAKMCFLM IFTFLVCWMP YIVICFLVVN GHGHLVTPTI SIVSYLFAKS  
 NTVYNPVIYV FMIRKFRRLS LQLLCLRLLR CQRPADLPA AGSEMQRPI VMSQKGDGRP  
 KKKVTFNSSS IIFIITSDES LSVDDSDKTN GSKVDVIQVR PL , which is disclosed  
 herein in the three letter amino acid code as set forth in SEQ ID NO:2.

10                    24.    The purified HG51 protein of claim 23 which consists of the amino acid sequence as set forth in SEQ ID NO:2.

25.    A method of identifying a substance which modulates HG51 receptor activity, comprising:  
 15                    (a)    combining a test substance in the presence and absence of a HG51 receptor protein wherein said HG51 receptor protein comprises the amino acid sequence as set forth in SEQ ID NO:2; and,  
                       (b)    measuring and comparing the effect of the test substance in the presence and absence of the HG51 receptor protein.

20                    26.    A method for determining whether a substance is a potential agonist or antagonist of HG51 comprising:  
                       (a)    transfecting or transforming cells with an expression vector of claim 3 that directs expression of HG51 in the cells, resulting in test cells;  
 25                    (b)    allowing the test cells to grow for a time sufficient to allow HG51 to be expressed;  
                       (c)    exposing the cells to a labeled ligand of HG51 in the presence and in the absence of the substance;  
                       (d)    measuring the binding of the labeled ligand to HG51; where if  
 30                    the amount of binding of the labeled ligand is less in the presence of the substance than in the absence of the substance, then the substance is a potential agonist or antagonist of HG51.

27. A method for determining whether a substance is capable of binding to HG51 comprising:

(a) transfecting or transforming cells with an expression vector of claim 3 that directs the expression of HG51 in the cells, resulting in test cells;

5 (b) exposing the test cells to the substance;

(c) measuring the amount of binding of the substance to HG51;

(d) comparing the amount of binding of the substance to HG51 in the test cells with the amount of binding of the substance to control cells that have not been transfected with HG51;

10 wherein if the amount of binding of the substance is greater in the test cells as compared to the control cells, the substance is capable of binding to HG51.

28. A method for determining whether a substance is capable of binding to HG51 comprising:

15 (a) transfecting or transforming cells with an expression vector of claim 3 that directs the expression of HG51 in the cells, resulting in test cells;

(b) preparing membranes containing HG51 from the test cells and exposing the membranes to a ligand of HG51 under conditions such that the ligand binds to the HG51 in the membranes;

20 (c) subsequently or concurrently to step (b), exposing the membranes from the test cells to a substance;

(d) measuring the amount of binding of the ligand to the HG51 in the membranes in the presence and the absence of the substance;

25 (e) comparing the amount of binding of the ligand to HG51 in the membranes in the presence and the absence of the substance where a decrease in the amount of binding of the ligand to HG51 in the membranes in the presence of the substance indicates that the substance is capable of binding to HG51.

29. A method for determining whether a substance is capable of binding to HG51 comprising:

30 (a) transfecting or transforming cells with an expression vector of claim 3 that directs the expression of HG51 in the cells, resulting in test cells;

(b) preparing membranes containing HG51 from the test cells and exposing the membranes from the test cells to the substance;

(c) measuring the amount of binding of the substance to the HG51 in the membranes from the test cells;

(d) comparing the amount of binding of the substance to HG51 in the membranes from the test cells with the amount of binding of the substance to  
5 membranes from control cells that have not been transfected with HG51, where if the amount of binding of the substance to HG51 in the membranes from the test cells is greater than the amount of binding of the substance to the membranes from the control cells, then the substance is capable of binding to HG51.

10 30. A method of identifying agonists of HG51 comprising:

(a) transfecting or transforming cells with a first expression vector of claim 3 which directs expression of HG51 and a second expression vector which directs the expression of a promiscuous G-protein, resulting in test cells;

(b) exposing the test cells to a substance that is a suspected agonist  
15 of HG51;

(c) measuring the level of inositol phosphates in the cells; where an increase in the level of inositol phosphates in the cells as compared to the level of inositol phosphates in the cells in the absence of the suspected agonist indicates that the substance is an agonist of HG51.

20

31. A method of identifying antagonists of HG51 comprising:

(a) transfecting or transforming cells with a first expression vector of claim 3 which directs expression of HG51 and a second expression vector which directs the expression of a promiscuous G-protein, resulting in test cells;

(b) exposing the test cells to a substance that is an agonist of  
25 HG51;

(c) subsequently or concurrently to step (b), exposing the test cells to a substance that is a suspected antagonist of HG51;

(d) measuring the level of inositol phosphates in the cells; where a  
30 decrease in the level of inositol phosphates in the cells in the presence of the suspected antagonist as compared to the level of inositol phosphates in the cells in the absence of the suspected antagonist indicates that the substance is an antagonist of HG51.

32. A method of identifying antagonists of HG51 as recited in claim 31 wherein the first and second expression vectors of step (a) are replaced with a single expression vector which expresses a chimeric HG51 protein fused at its C-terminus to a promiscuous G-protein.

5

33. An antibody that binds specifically to HG51 protein wherein the HG51 receptor protein comprises the amino acid sequence as set forth in SEQ ID NO:2.

GGGGCCACGG GGGGTGCGCC GGGCGCGGGT AGCGCGGGCC CCTCAGTGCA CAATGGCCAG	60
AGCAGGCGGC GGAGCCCCAG CCCACCCAG TGGGAGCGC GCCCGAGCC CCGCCGAAG	120
CTGAGCGCT CCGCCGCCA GGGCGCGCG CGCGGGCCA TGACTCGG GAACCGCAGC	180
GGCGGCCACG GCTACTGGA GGGCGCGGG GCGCGGGCG CTGAGGGCC GCGCGCGCG	240
GGGACACTGA GCGCGCGCC CCTCTTCAGC CCGGCACCT ACGAGCGCT GCGCTGCTG	300
CTGGGCTCCA TTGGCTGCT GGGCGTCGC AACAACTGC TGGTCTCGT CCTCTACTAC	360
AAGTTCAGC GGCTCGCAC TCCACTCAC CTCCTCTGG TCAACATCAG CCTCAGCAGC	420
CTGCTGGTGT CCTCTTCGG GGTACCTTT ACCTTCGTGT CCTGCCTGAG GAACGCTGG	480
GTGTGGACA CCGTGGGCTG CGTGTGGAC GGGTTAGCG GCAGCCTCTT CGGGATTGTT	540
TCCATTGCCA CCCTAACCGT GCTGGCCTAT GAACGTTACA TTGCGTGGT CCATGCCAGA	600
GTGATCAATT TTTCCTGGC CTGGAGGGCC ATTACCTACA TCTGGCTCTA CTCACTGGCG	660
TGGGAGGAG CACCTCTCT GGGATGGAAC AGGTACATCC TGAAGTACA CGGACTAGGC	720
TGCACTGTGG ACTGAAATC CAAGATGCC AAGATTCTT CTTTGTGCT TTTCTATTT	780
CTTGGCTGCC TGGTGGTGCC CCTGGGTGC ATAGCCATT GCTATGGCA TATTCTATAT	840
TCCATTGAA TGCTTCGTG TGTGAAGAT CTTAGACAA TTCAAGTAT CAAGATTTTA	900
AAATATGAAA AGAACTGGC CAAAATGTG TTTTAAATGA TATCACCTT CCTGGTCTGT	960
TGGATGCCTT ATATCGTAT CTGCTTCTG GTGGTAAATG GTCATGGTCA CCTGGTCACT	1020
CCAACAATAT CTATTGTTT GTACCTCTT GCTAAATGA AACTGTATA CAATCCAGTG	1080
ATTTATGTCT TCATGATCAG AAAGTTTCGA AGATCCCTT TGCAGCTTCT GTGCCTCCGA	1140
CTGCTGAGGT GCCAGAGGCC TGCTAAAGAC CTACCAGCAG CTGGAAGTGA AATGCAGATC	1200
AGACCCATTG TGATGTCACA GAAAGATGG GACAGGCCAA AGAAAAAGT GACTTTCAAC	1260
TCTTCTTCCA TCATTTTAT CATCACCAGT GATGAATCAC TGTCAGTTGA CGACAGCGAC	1320
AAAACCAATG GGTCCAAAGT TGATGTAATC CAAGTTCGT CTTTGTAGGA ATGAAGAATG	1380
GCAACGAAAG ATGGGCGCTT AAATTGGATG CCACTTTTGG ACTTTCATCA TAAGAAGTGT	1440
CTGGAATACC CGTCTATGT AATATCAACA GAACCTTGT GTCCAGCAGG AAATCCGAAT	1500
TGCCATATG CTCTGGGCC TCAGGAAGAG GTTGAAC (SEQ ID NO:1)	1537

FIG.1



1 MYSGNRSGGH GYWDGGAAG AEGPAPAGTL SPAPLFSPGT YERLALLLGS  
51 IGLLGVCNNL LVLVLYYKFQ RLRTPTHLLV VNISLSDLLV SLFGVTFTFV  
101 SCLRNGWWD TVGCWWDGFS GSLFGIVSIA TLTVLAYERY IRVVHARVIN  
151 FSWAWRAITY IWLYSLAWAG APLLGNRYI LDVHGLGCTV DWKSKDANDS  
201 SFVLFLFLGC LVVPLGVIAH CYGHILYSIR MLRCVEDLQT IQVIKILKYE  
251 KKLAKMCFLM IFTFLVCWMP YIVICFLVN GHGHLVTPTI SIVSYLFAKS  
301 NTVYNPVIYV FMIRKFRRSL LQLLCLRLLR CQPAKDLPA AGSEMQRPI  
351 VMSQKDGDRP KKKVTFNSSS IIFIITSDES LSVDDSDKTN GSKVDVIQVR  
401 PL (SEQ ID NO:2)

FIG.2

3/8

GGGGCCACGG GGGGTGCGCC GGCGCGCGGT AGCGCGGGCC CCTCAGTGCA CAATGCCAG	60
AGCAGGCGGC GGAGCCCCAG CCCCACCCAG TGCGGAGCGC GCGCGAGCC CCGCCGAAG	120
CTGAGCGCCT CCGCCGCCA GGCGCGCGG CGCGGGCC ATG TAC TCG GGG AAC	174
MET TYR SER GLY ASN	
1 5	
CGC AGC GGC GGC CAC GGC TAC TGG GAC GGC GGC GGG GCC GCG GGC GCT	222
ARG SER GLY GLY HIS GLY TYR TRP ASP GLY GLY GLY ALA ALA GLY ALA	
10 15 20	
GAG GGC CCG GCG CCG GCG GGC ACA CTG AGC CCC GCG CCC CTC TTC AGC	270
GLU GLY PRO ALA PRO ALA GLY THR LEU SER PRO ALA PRO LEU PHE SER	
25 30 35	
CCC GGC ACC TAC GAG CGC CTG GCG CTG CTG CTG GGC TCC ATT GGG CTG	318
PRO GLY THR TYR GLU ARG LEU ALA LEU LEU LEU GLY SER ILE GLY LEU	
40 45 50	
CTG GGC GTC GGC AAC AAC CTG CTG GTG CTC GTC CTC TAC TAC AAG TTC	366
LEU GLY VAL GLY ASN ASN LEU LEU VAL LEU VAL LEU TYR TYR LYS PHE	
55 60 65	
CAG CGG CTC CGC ACT CCC ACT CAC CTC CTC CTG GTC AAC ATC AGC CTC	414
GLN ARG LEU ARG THR PRO THR HIS LEU LEU LEU VAL ASN ILE SER LEU	
70 75 80 85	
AGC GAC CTG CTG GTG TCC CTC TTC GGG GTC ACC TTT ACC TTC GTG TCC	462
SER ASP LEU LEU VAL SER LEU PHE GLY VAL THR PHE THR PHE VAL SER	
90 95 100	
TGC CTG AGG AAC GGC TGG GTG TGG GAC ACC GTG GGC TGC GTG TGG GAC	510
CYS LEU ARG ASN GLY TRP VAL TRP ASP THR VAL GLY CYS VAL TRP ASP	
105 110 115	
GGG TTT AGC GGC AGC CTC TTC GGG ATT GTT TCC ATT GCC ACC CTA ACC	558
GLY PHE SER GLY SER LEU PHE GLY ILE VAL SER ILE ALA THR LEU THR	
120 125 130	
GTG CTG GCC TAT GAA CGT TAC ATT CGC GTG GTC CAT GCC AGA GTG ATC	606
VAL LEU ALA TYR GLU ARG TYR ILE ARG VAL VAL HIS ALA ARG VAL ILE	
135 140 145	

FIG. 3A

4/8

AAT TTT TCC TGG GCC TGG AGG GCC ATT ACC TAC ATC TGG CTC TAC TCA ASN PHE SER TRP ALA TRP ARG ALA ILE THR TYR ILE TRP LEU TYR SER 150 155 160 165	654
CTG GCG TGG GCA GGA GCA CCT CTC CTG GGA TGG AAC AGG TAC ATC CTG LEU ALA TRP ALA GLY ALA PRO LEU LEU GLY TRP ASN ARG TYR ILE LEU 170 175 180	702
GAC GTA CAC GGA CTA GGC TGC ACT GTG GAC TGG AAA TCC AAG GAT GCC ASP VAL HIS GLY LEU GLY CYS THR VAL ASP TRP LYS SER LYS ASP ALA 185 190 195	750
AAC GAT TCC TCC TTT GTG CTT TTC TTA TTT CTT GGC TGC CTG GTG GTG ASN ASP SER SER PHE VAL LEU PHE LEU PHE LEU GLY CYS LEU VAL VAL 200 205 210	798
CCC CTG GGT GTC ATA GCC CAT TGC TAT GGC CAT ATT CTA TAT TCC ATT PRO LEU GLY VAL ILE ALA HIS CYS TYR GLY HIS ILE LEU TYR SER ILE 215 220 225	846
CGA ATG CTT CGT TGT GTG GAA GAT CTT CAG ACA ATT CAA GTG ATC AAG ARG MET LEU ARG CYS VAL GLU ASP LEU GLN THR ILE GLN VAL ILE LYS 230 235 240 245	894
ATT TTA AAA TAT GAA AAG AAA CTG GCC AAA ATG TGC TTT TTA ATG ATA ILE LEU LYS TYR GLU LYS LYS LEU ALA LYS MET CYS PHE LEU MET ILE 250 255 260	942
TTC ACC TTC CTG GTC TGT TGG ATG CCT TAT ATC GTG ATC TGC TTC TTG PHE THR PHE LEU VAL CYS TRP MET PRO TYR ILE VAL ILE CYS PHE LEU 265 270 275	990
GTG GTT AAT GGT CAT GGT CAC CTG GTC ACT CCA ACA ATA TCT ATT GTT VAL VAL ASN GLY HIS GLY HIS LEU VAL THR PRO THR ILE SER ILE VAL 280 285 290	1038
TCG TAC CTC TTT GCT AAA TCG AAC ACT GTA TAC AAT CCA GTG ATT TAT SER TYR LEU PHE ALA LYS SER ASN THR VAL TYR ASN PRO VAL ILE TYR 295 300 305	1086
GTC TTC ATG ATC AGA AAG TTT CGA AGA TCC CTT TTG CAG CTT CTG TGC VAL PHE MET ILE ARG LYS PHE ARG ARG SER LEU LEU GLN LEU LEU CYS 310 315 320 325	1134

FIG. 3B

5/8

CTC CGA CTG CTG AGG TGC CAG AGG CCT GCT AAA GAC CTA CCA GCA GCT	1182
LEU ARG LEU LEU ARG CYS GLN ARG PRO ALA LYS ASP LEU PRO ALA ALA	
330 335 340	
CGA AGT GAA ATG CAG ATC AGA CCC ATT GTG ATG TCA CAG AAA GAT GGG	1230
GLY SER GLU MET GLN ILE ARG PRO ILE VAL MET SER GLN LYS ASP GLY	
345 350 355	
GAC AGG CCA AAG AAA AAA GTG ACT TTC AAC TCT TCT TCC ATC ATT TTT	1278
ASP ARG PRO LYS LYS LYS VAL THR PHE ASN SER SER SER ILE ILE PHE	
360 365 370	
ATC ATC ACC AGT GAT GAA TCA CTG TCA GTT GAC GAC AGC GAC AAA ACC	1326
ILE ILE THR SER ASP GLU SER LEU SER VAL ASP SER ASP LYS THR	
375 380 385	
AAT GGG TCC AAA GTT GAT GTA ATC CAA GTT CGT CCT TTG TAGGAATGAA	1375
ASN GLY SER LYS VAL ASP VAL ILE GLN VAL ARG PRO LEU (SEQ ID NO:2)	
390 395 400	
GAATGGCAAC GAAAGATGGG GCCTTAAATT GGATGCCACT TTTGGACTTT CATCATAAGA	1435
AGTGCTCTGGA ATACCCGTTT TATGTAATAT CAACAGAACC TTGTGGTCCA GCAGGAAATC	1495
CGAATTGCCC ATATGCTCTT GGGCCTCAGG AAGAGGTTGA AC (SEQ ID NO:2)	1537

FIG. 3C

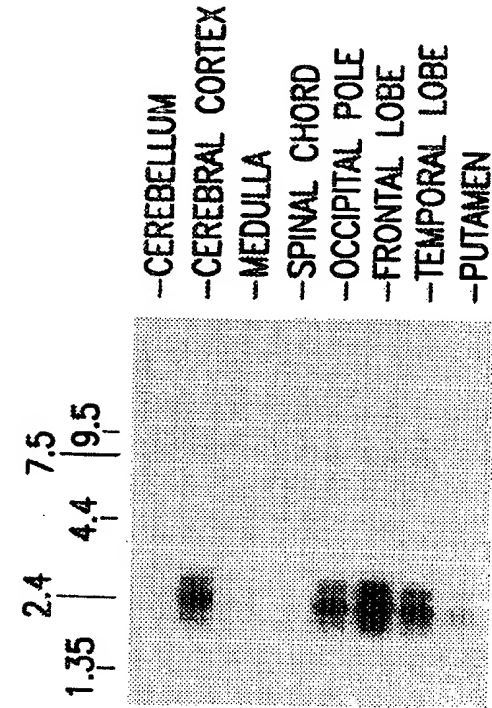


FIG.4B

6/8

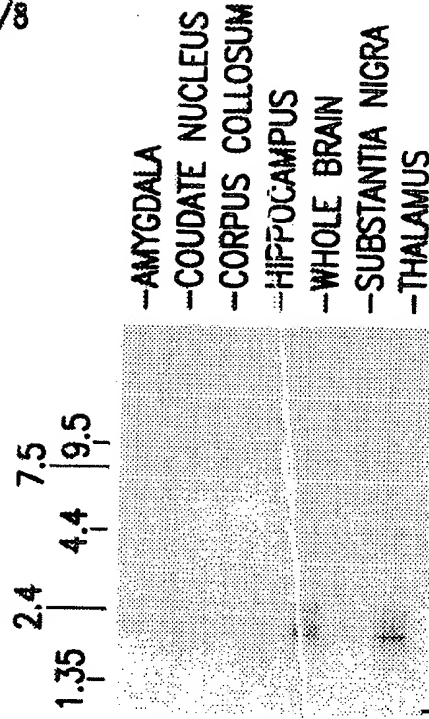


FIG.4D

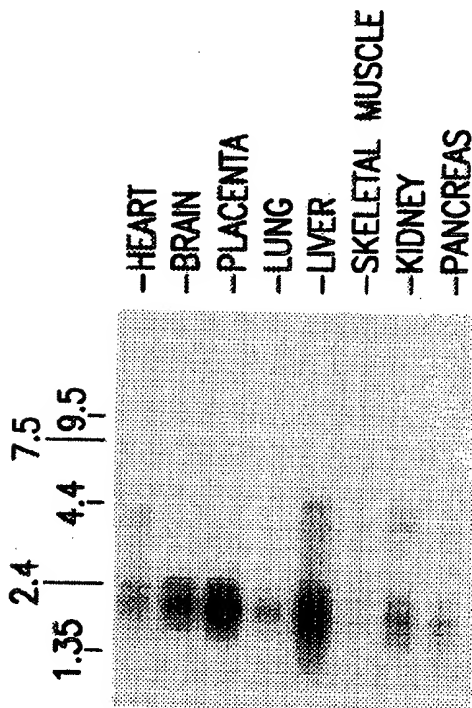


FIG.4A

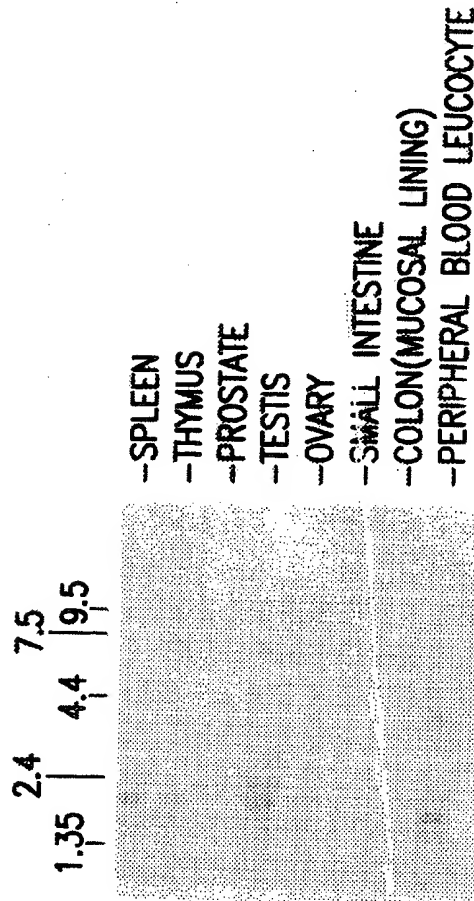


FIG.4C

7/8

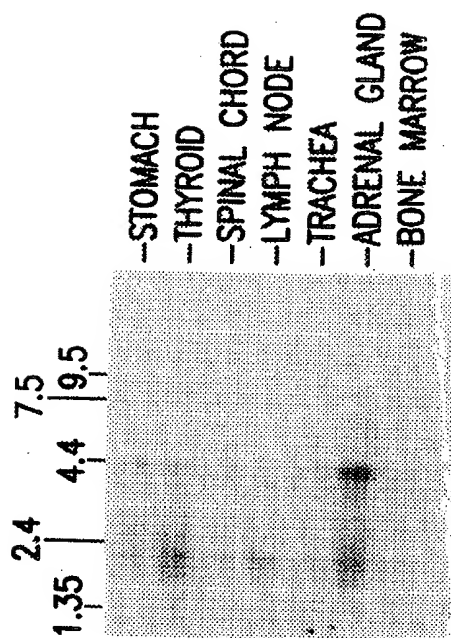


FIG.4E

8/8

	10	20	30	40	50	60
RHODOPSIN	MNGTEGPNFYVPF	SNATGVVRSPFEY	PQYYLAEPWQFS	MLAAYMFL	IVLGFPIN	FLTLTY
			I I : II : : II	I : I		
HG51	NRSGGHGYWDGGA	GAEGPAPAGT	LSAPLFS	PGTYERL	ALLG	SI
	10	20	30	40	50	60
	70	80	90	100	110	120
RHODOPSIN	VTVQHKKLRTP	LNILLNLAVAD	LFMVLGGFT	STLYTSLHGY	FVFGPTGCN	LEGFFATLG
	: : : III	: : I : : : I	: : I : : I	: : I : : I	: : I : : I	: : I : : I
HG51	LYYKFQRLRTP	THLLVNI	SLSDLLVSL	FGVTFTV	SCLRNGW	WDTVGCW
	70	80	90	100	110	120
	130	140	150	160	170	179
RHODOPSIN	GEIALWSLV	LAIERYV	-VCKPMSN	FRFGENH	AIMGVAF	TWVMALACA
	I : : : I	: : I : : I	: : I : : I	: : I : : I	: : I : : I	: : I : : I
HG51	GIVSIATLT	VLAYERI	RVVHARV	INF	SW----	AWRAITYI
	130	140	150	160	170	180
	180	190	200	210	220	230
RHODOPSIN	PEGLQCSCG	IDYYTLKPE	VNNESFVI	YMFVVFH	TIPMII	IFFCYGQL
	: : : I	: : I : : I	: : I : : I	: : I : : I	: : I : : I	: : I : : I
HG51	LDVHGLGCT	VDWKS--	KDANDSS	FLFLGCL	VVPLGVIA	HCYGHILY
	190	200	210	220	230	
	240	250	260	270	280	290
RHODOPSIN	QQQESATTQ	KAKEVTRM	VIIMVIAFL	ICWVPYAS	VAFYIFTH	QGSNFGPI
	I : : I	: : I : : I	: : I : : I	: : I : : I	: : I : : I	: : I : : I
HG51	QTIQVIKIL	KYEKKLAK	MCFLMIFT	FLVCWMPY	IVICFLV	NGHGLV
	240	250	260	270	280	290
	300	310	320	330	340	
RHODOPSIN	KSAAIYNP	VIYIMN	KQFRNCML	TTICCGKN	PLGDDEAS	ATVSKTETS
	II : : I	: : I : : I	: : I : : I	: : I : : I	: : I : : I	: : I : : I
HG51	KSNTVYNP	VIYVFMIR	KFRSLL	QLLLCL	RLRCQRP	AKDLPAAG
	300	310	320	330	340	350
						(CONTAINED WITHIN SEQ. ID NO:2)

FIG. 5

## SEQUENCE LISTING

&lt;110&gt; Merck &amp; Co., Inc.

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G PROTEIN-COUPLED RECEPTOR

&lt;130&gt; 20351 PCT

&lt;150&gt; 60/109,717

&lt;151&gt; 1998-11-24

&lt;160&gt; 15

&lt;170&gt; FastSEQ for Windows Version 4.0

&lt;210&gt; 1

&lt;211&gt; 1537

&lt;212&gt; DNA

&lt;213&gt; Homo sapien (human)

&lt;400&gt; 1

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ctgagcgcct ccgcccgcca ggcgcgcggt cgcggggcca tgtactcggg gaaccgcagc      180
ggcggccacg gctactggga cggcggcggg gccgcggggc ctgagggggc ggcgcgggag      240
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atztatgtct tcatgatcag aaagtttcga agatcccttt tgcagcttct gtgcctccga     1140
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1537

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&lt;211&gt; 402

&lt;212&gt; PRT

&lt;213&gt; Homo sapien (human)



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 35 40 45  
 Gly Ser Ile Gly Leu Leu Gly Val Gly Asn Asn Leu Leu Val Leu Val  
 50 55 60  
 Leu Tyr Tyr Lys Phe Gln Arg Leu Arg Thr Pro Thr His Leu Leu Leu  
 65 70 75 80  
 Val Asn Ile Ser Leu Ser Asp Leu Leu Val Ser Leu Phe Gly Val Thr  
 85 90 95  
 Phe Thr Phe Val Ser Cys Leu Arg Asn Gly Trp Val Trp Asp Thr Val  
 100 105 110  
 Gly Cys Val Trp Asp Gly Phe Ser Gly Ser Leu Phe Gly Ile Val Ser  
 115 120 125  
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 130 135 140  
 His Ala Arg Val Ile Asn Phe Ser Trp Ala Trp Arg Ala Ile Thr Tyr  
 145 150 155 160  
 Ile Trp Leu Tyr Ser Leu Ala Trp Ala Gly Ala Pro Leu Leu Gly Trp  
 165 170 175  
 Asn Arg Tyr Ile Leu Asp Val His Gly Leu Gly Cys Thr Val Asp Trp  
 180 185 190  
 Lys Ser Lys Asp Ala Asn Asp Ser Ser Phe Val Leu Phe Leu Phe Leu  
 195 200 205  
 Gly Cys Leu Val Val Pro Leu Gly Val Ile Ala His Cys Tyr Gly His  
 210 215 220  
 Ile Leu Tyr Ser Ile Arg Met Leu Arg Cys Val Glu Asp Leu Gln Thr  
 225 230 235 240  
 Ile Gln Val Ile Lys Ile Leu Lys Tyr Glu Lys Lys Leu Ala Lys Met  
 245 250 255  
 Cys Phe Leu Met Ile Phe Thr Phe Leu Val Cys Trp Met Pro Tyr Ile  
 260 265 270  
 Val Ile Cys Phe Leu Val Val Asn Gly His Gly His Leu Val Thr Pro  
 275 280 285  
 Thr Ile Ser Ile Val Ser Tyr Leu Phe Ala Lys Ser Asn Thr Val Tyr  
 290 295 300  
 Asn Pro Val Ile Tyr Val Phe Met Ile Arg Lys Phe Arg Arg Ser Leu  
 305 310 315 320  
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 325 330 335  
 Asp Leu Pro Ala Ala Gly Ser Glu Met Gln Ile Arg Pro Ile Val Met  
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 Ser Gln Lys Asp Gly Asp Arg Pro Lys Lys Lys Val Thr Phe Asn Ser  
 355 360 365  
 Ser Ser Ile Ile Phe Ile Ile Thr Ser Asp Glu Ser Leu Ser Val Asp  
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 385 390 395 400  
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&lt;213&gt; Homo sapien (human)

&lt;400&gt; 3

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ccacgggtgtc ccacaccag ccgttcctca ggcaggacac gaaggtaaag gtgaccccga	240
agaggtacac agcagggtcg tgaggctgat gttgaccagg aggaggtgag tgggagtgcg	300
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&lt;220&gt;

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&lt;212&gt; DNA

&lt;213&gt; Artificial Sequence

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&lt;223&gt; Oligonucleotide

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&lt;213&gt; Artificial Sequence

&lt;220&gt;

&lt;223&gt; Oligonucleotide

&lt;400&gt; 6

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&lt;211&gt; 22

&lt;212&gt; DNA

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&lt;223&gt; Oligonucleotide

&lt;400&gt; 14

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25

&lt;210&gt; 15

&lt;211&gt; 348

&lt;212&gt; PRT

&lt;213&gt; Homo sapien (human)

&lt;400&gt; 15

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Thr	Gly	Val	Val	Arg	Ser	Pro	Phe	Glu	Tyr	Pro	Gln	Tyr	Tyr	Leu	Ala
			20					25					30		
Glu	Pro	Trp	Gln	Phe	Ser	Met	Leu	Ala	Ala	Tyr	Met	Phe	Leu	Leu	Ile
		35					40					45			
Val	Leu	Gly	Phe	Pro	Ile	Asn	Phe	Leu	Thr	Leu	Tyr	Val	Thr	Val	Gln
		50				55					60				
His	Lys	Lys	Leu	Arg	Thr	Pro	Leu	Asn	Tyr	Ile	Leu	Leu	Asn	Leu	Ala
65				70					75					80	
Val	Ala	Asp	Leu	Phe	Met	Val	Leu	Gly	Gly	Phe	Thr	Ser	Thr	Leu	Tyr
			85					90					95		
Thr	Ser	Leu	His	Gly	Tyr	Phe	Val	Phe	Gly	Pro	Thr	Gly	Cys	Asn	Leu
			100					105					110		
Glu	Gly	Phe	Phe	Ala	Thr	Leu	Gly	Gly	Glu	Ile	Ala	Leu	Trp	Ser	Leu
		115				120						125			
Val	Val	Leu	Ala	Ile	Glu	Arg	Tyr	Val	Val	Val	Cys	Lys	Pro	Met	Ser
		130				135					140				
Asn	Phe	Arg	Phe	Gly	Glu	Asn	His	Ala	Ile	Met	Gly	Val	Ala	Phe	Thr
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Trp	Val	Met	Ala	Leu	Ala	Cys	Ala	Ala	Pro	Pro	Leu	Ala	Gly	Trp	Ser
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			180					185					190		

Thr Leu Lys Pro Glu Val Asn Asn Glu Ser Phe Val Ile Tyr Met Phe  
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 225 230 235 240  
 Ala Thr Thr Gln Lys Ala Glu Lys Glu Val Thr Arg Met Val Ile Ile  
 245 250 255  
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 260 265 270  
 Phe Tyr Ile Phe Thr His Gln Gly Ser Asn Phe Gly Pro Ile Phe Met  
 275 280 285  
 Thr Ile Pro Ala Phe Phe Ala Lys Ser Ala Ala Ile Tyr Asn Pro Val  
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 Ile Tyr Ile Met Met Asn Lys Gln Phe Arg Asn Cys Met Leu Thr Thr  
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 325 330 335  
 Val Ser Lys Thr Glu Thr Ser Gln Val Ala Pro Ala  
 340 345

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/27305

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : Please See Extra Sheet.

US CL : 435/7.2, 69.1, 252.3, 320.1, 325; 536/23.1; 530/350, 387.9

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 435/7.2, 69.1, 252.3, 320.1, 325; 536/23.1; 530/350, 387.9

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
MEDLINE, WEST, CAPLUS

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	HAN et al. The C9 methyl group of retinal interacts with glycine-121 in rhodopsin. Proc. Natl. Acad. Sci. USA. December 1997, Vol. 94, 13442-13447, especially page 13443.	25-33
A	LEE et al. Molecular Biology of G-Protein-Coupled Receptors. DN&P. September 1993, Vol. 6, No. 7, pages 488-497, Figure 3.	1-24
A	HODGSON, J. Receptor Screening and the Search for New Pharmaceuticals. Bio/Technology. 10 September 1992, Vol. 10, pages 973-977, especially page 975.	1-33

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E* earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*G* document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means	
*P* document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

14 FEBRUARY 2000

Date of mailing of the international search report

02 MAR 2000

Name and mailing address of the ISA/US  
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Box PCT  
Washington, D.C. 20231

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Authorized officer

JOSEPH F. MURPHY

Telephone No. (703) 308-0196

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/27305

## C (Continuation). DOCUMENTS CONSIDERED TO BE RÉLEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	STRADER et al. Structure and Function of G Protein-Coupled Receptors. Annu. Rev. Biochem. 1994, Vol. 63, pages 101-132, especially Figure 1.	1-33

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US99/27305

A. CLASSIFICATION OF SUBJECT MATTER:  
IPC (7):

C07H 21/04; C07K 14/00, 16/28; C12N 1/21, 5/02, 15/00; C12P 21/00; G01N 33/53, 33/567



1. A purified DNA molecule encoding HG51 which comprises the nucleotide sequence:

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CTGAGCGCCT CCGCCCGCCA GCGCGCGCGG CGCGCGGCCA TGTACTCGGG GAACCGCAGC  
GGCGGCCACG GCTACTGGGA CCGCGCGCGG GCGCGCGGCG CTGAGGGGCG GCGCGCGGCG  
GGGACACTGA GCGCGCGGCC CCTCTTCAGC CCGCGCACCT CGAGCGCGCT GCGCGTACTG  
CTGGGTCCA TTGGGTGCT GGGGTGCGG AACAACCTGC TGTGTCTGTT CCTTACTAC  
AAGTTCCAGC GGTCCCGCAC TCCCACTCAC CTCTCTCGT TCAACATCAG CTTACAGGAC  
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GTGTGGGACA CCGTGGGCTG CCGTGTAGCG GGTGTAGCG CGAGCGCTCT CCGGATTGTT  
TCCATTGCCA CCTAACCGT GCTGGCTAT GAACCTTACA TTGCGTGT CATGCCAGA  
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TGCAGTGGG ACTGGGAATC CAAGGATGCG GGTGTAGCG CTTGTGTCTT TTCTTATT  
CTTGGCTGCC TGGTGTGCC CCTGGGTGTC ATAGCCCAT GCTATGGCCA TATTCTATAT  
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GCAACGAAAG ATGGGGCCTT AAATGGATG CCACTTTTGG ACTTTTCACTA TAAGAAGTGT  
CTGAATACC CTTCTATGT AATATCAACA GAACCTTGTG GTCCAGCAGG AATCCGAAT  
TGCCCATATG CTCTTGGGCC TCAGGAAGAG GTTGAAC , disclosed herein as SEQ ID  
NO:1.

2. A purified DNA molecule encoding human HG51 wherein said DNA molecule encodes a protein comprising the amino acid sequence:

MYSGNRSGH GYWDGGGAA AEGPAPOTL SPAPLSPOT YERLALLLS IGLLVGNL  
LVLVLYYFQ RLRTPTLHL VNISLSDLLV SLFGVTFPV SCLRNGVND TVGCVMDGS  
GSLPQIVSIA TLTVLAYERY IRVHARVIN PSWAWRAITY IWLVSANAG APLLGWNYI  
LDVHGLGCTV DWKSKDANDS SPVLPLFLGC LVVPLGVIAH CYGHLYSIR MLRCVEDLQT  
IQVIXILKYE KKLAKMCFM IFTPLVCMF YIVICPLVN GHGLVPTPI SIVSYLFAKS  
NTVYNFVIY FMIRKFRSL LQLLCLRLR CQRPAXDLPA AGSEMQRPI VMSQKQDRP  
KXKVPFNSG IIPITSDBS LSVDDSDKN GSKVDVQVR PL , which is disclosed herein  
in the three letter amino acid code as set forth in SEQ ID NO:2.

3. An expression vector for the expression of a HG51 protein in a recombinant host cell wherein said expression vector comprises a DNA molecule which encodes the amino acid sequence of claim 2.

4. An expression vector of claim 3 which is a eukaryotic expression vector.

5. An expression vector of claim 3 which is a prokaryotic expression vector.

6. A host cell which expresses a recombinant HG51 protein wherein said host cell contains the expression vector of claim 3.

7. A host cell which expresses a recombinant HG51 protein wherein said host cell contains the expression vector of claim 4.

8. A host cell which expresses a recombinant HG51 protein wherein said host cell contains the expression vector of claim 5.

9. A subcellular membrane fraction obtained from the host cell of claim 6 which contains recombinant HG51.

10. A subcellular membrane fraction obtained from the host cell of claim 7 which contains recombinant HG51.

11. A subcellular membrane fraction obtained from the host cell of claim 8 which contains recombinant HG51.

12. A purified DNA molecule encoding HG51 which consists of the nucleotide sequence:

GGGCGCACGG GGGGTGCGCC GCGCGCGGTT AGCGCGGGCC CCTCAGTCCA CAATGGCCAG  
AGCAGGCGGC GAGGCCCCAG CCCCACCCAG TCGCGAGGCG GCGCGGAGCC CCGCCGCAAG  
CTGAGCGCCT CCGCCCGCCA GCGCGCGCGG CGCGCGGCCA TGTACTCGGG GAACCGCAGC  
GGCGGCCACG GCTACTGGGA CCGCGCGCGG GCGCGCGGCG CTGAGGGGCG GCGCGCGGCG  
GGGACACTGA GCGCGCGGCC CCTCTTCAGC CCGCGCACCT CGAGCGCGCT GCGCGTACTG  
CTGGGTCCA TTGGGTGCT GGGGTGCGG AACAACCTGC TGTGTCTGTT CCTTACTAC  
AAGTTCCAGC GGTCCCGCAC TCCCACTCAC CTCTCTCGT TCAACATCAG CTTACAGGAC  
CTGTGTGTT CCTCTTCGG GGTCACTTTT ACCTTCGTGT CTTGCTGAG GAACGGCTGG  
GTGTGGGACA CCGTGGGCTG CCGTGTAGCG GGTGTAGCG CGAGCGCTCT CCGGATTGTT  
TCCATTGCCA CCTAACCGT GCTGGCTAT GAACCTTACA TTGCGTGT CATGCCAGA  
GTGATCAATT TTCTCTGGG CTGAGGGGCC ATTACTACA TGTGCTCTA CTCAGTGGG  
TGGCAGGAG CACCTCTCT GGGATGGAAC AGGTACATCC TGGAGTACA CGGACTAGGC  
TGCAGTGGG ACTGGGAATC CAAGGATGCG GGTGTAGCG CTTGTGTCTT TTCTTATT  
CTTGGCTGCC TGGTGTGCC CCTGGGTGTC ATAGCCCAT GCTATGGCCA TATTCTATAT  
TCCATTGAAA TGCTCTGGT TGTGGAAGAT CTTGAGACAA TTCAAGTAT CAAGATTTTA  
AAATATGAAA AGAACTGGC CAAATGTGC TTTTAAATGA TATTCACTT CTTGTCTGT  
TGTATGCTT ATATCTGAT CTGCTCTTG GTGTGTAATG GTGATGTTA GTCAGCTTCT  
CCAACAATAT CTATTGTTT GTACCTCTT GCTAAATCGA ACACGTGATA CAATCCAGTG  
ATTATGTCT TCATGATCAG AAGTTTCTG AGATCCCTT TGCAGCTCT GTGCTCCGA  
CTGTGAGGT GCCAGAGGCC TGCTAAAGAC CTACACGAG CTGGAAGTGA AATGCAGATC  
AGACCCATTG TGATGTACA GAAAGATGG GACAGGCCAA AGAAAAAGT GACTTTCAAC  
TCTTCTTCCA TCATTTTAT CATCACCAGT GATGAATCAC TGTCACTTGA CGACAGCGAC  
AAAACCAATG GGTCCAAAGT TGATGTAATC CAAGTCTGTC CTTGTAGGA ATGAAGAATG  
GCAACGAAAG ATGGGGCCTT AAATGGATG CCACTTTTGG ACTTTTCACTA TAAGAAGTGT  
CTGAATACC CTTCTATGT AATATCAACA GAACCTTGTG GTCCAGCAGG AATCCGAAT  
TGCCCATATG CTCTTGGGCC TCAGGAAGAG GTTGAAC , disclosed herein as SEQ ID  
NO:1.

13. The purified DNA molecule of claim 12 which consists of a nucleotide sequence from nucleotide 160 to nucleotide 1368 of SEQ ID NO:1.

14. An expression vector for the expression of a HG51 protein in a recombinant host cell wherein said expression vector comprises a DNA molecule of claim 13.

15. An expression vector of claim 14 which is a eukaryotic expression vector.

16. An expression vector of claim 14 which is a prokaryotic expression vector.

17. A host cell which expresses a recombinant HG51 protein wherein said host cell contains the expression vector of claim 14.

18. A host cell which expresses a recombinant HG51 protein wherein said host cell contains the expression vector of claim 15.

19. A host cell which expresses a recombinant HG51 protein wherein said host cell contains the expression vector of claim 16.

20. A subcellular membrane fraction obtained from the host cell of claim 17 which contains recombinant HG51 protein.

21. A subcellular membrane fraction obtained from the host cell of claim 18 which contains recombinant HG51 protein.

22. A subcellular membrane fraction obtained from the host cell of claim 19 which contains recombinant HG51 protein.

23. A purified HG51 protein which comprises the amino acid sequence:

MYSGNRSGGH GYWDGGAAG AEGPAPAGTL SPAPLPSPT YERLALLGS IGLGVGNL  
LVLVLYKFO RLRTPTLLL VNISLSDLV SLFQVTFV SCIRNGVWD TVGCVWDQFS  
GSLPGIVSIA TLTLVAYER IRVVEARVIN FSWANRAITY IWLYSANAG AFLLOWNRYI  
LDVHGLGCTV DNKSKDANDS SPVLFLPLGC LVVPLGVIAH CYGHILYSIR MLRCVEDLQT  
IQVIKILKYE KKLAKMCFM IPTPLVCMWP YIVICFLVN GHGHLVTPTI SIVSYLFAKS  
NTVNPVTIY FMIRKFRSL LQLLCLALLR CQRPADLPA AGSEMQIRPI VMSQKGDPRP  
KKKVTFNSSS IIFIITSDS LQVDDSKTN GSKVDVIQVR PL, which is disclosed  
herein in the three letter amino acid code as set forth in SEQ ID NO:2.

24. The purified HG51 protein of claim 23 which consists of the amino acid sequence as set forth in SEQ ID NO:2.

25. A method of identifying a substance which modulates HG51 receptor activity, comprising:

- (a) combining a test substance in the presence and absence of a HG51 receptor protein wherein said HG51 receptor protein comprises the amino acid sequence as set forth in SEQ ID NO:2; and,
- (b) measuring and comparing the effect of the test substance in the presence and absence of the HG51 receptor protein.

26. A method for determining whether a substance is a potential agonist or antagonist of HG51 comprising:

- (a) transfecting or transforming cells with an expression vector of claim 3 that directs expression of HG51 in the cells, resulting in test cells;
- (b) allowing the test cells to grow for a time sufficient to allow HG51 to be expressed;
- (c) exposing the cells to a labeled ligand of HG51 in the presence and in the absence of the substance;
- (d) measuring the binding of the labeled ligand to HG51; where if the amount of binding of the labeled ligand is less in the presence of the substance than in the absence of the substance, then the substance is a potential agonist or antagonist of HG51.

27. A method for determining whether a substance is capable of binding to HG51 comprising:

- (a) transfecting or transforming cells with an expression vector of claim 3 that directs the expression of HG51 in the cells, resulting in test cells;
  - (b) exposing the test cells to the substance;
  - (c) measuring the amount of binding of the substance to HG51;
  - (d) comparing the amount of binding of the substance to HG51 in the test cells with the amount of binding of the substance to control cells that have not been transfected with HG51;
- wherein if the amount of binding of the substance is greater in the test cells as compared to the control cells, the substance is capable of binding to HG51.

28. A method for determining whether a substance is capable of binding to HG51 comprising:

- (a) transfecting or transforming cells with an expression vector of claim 3 that directs the expression of HG51 in the cells, resulting in test cells;
- (b) preparing membranes containing HG51 from the test cells and exposing the membranes to a ligand of HG51 under conditions such that the ligand binds to the HG51 in the membranes;
- (c) subsequently or concurrently to step (b), exposing the membranes from the test cells to a substance;
- (d) measuring the amount of binding of the ligand to the HG51 in the membranes in the presence and the absence of the substance;
- (e) comparing the amount of binding of the ligand to HG51 in the membranes in the presence and the absence of the substance where a decrease in the amount of binding of the ligand to HG51 in the membranes in the presence of the substance indicates that the substance is capable of binding to HG51.

29. A method for determining whether a substance is capable of binding to HG51 comprising:

- (a) transfecting or transforming cells with an expression vector of claim 3 that directs the expression of HG51 in the cells, resulting in test cells;
- (b) preparing membranes containing HG51 from the test cells and exposing the membranes from the test cells to the substance;
- (c) measuring the amount of binding of the substance to the HG51 in the membranes from the test cells;
- (d) comparing the amount of binding of the substance to HG51 in the membranes from the test cells with the amount of binding of the substance to membranes from control cells that have not been transfected with HG51, where if the amount of binding of the substance to HG51 in the membranes from the test cells is greater than the amount of binding of the substance to the membranes from the control cells, then the substance is capable of binding to HG51.

30. A method of identifying agonists of HG51 comprising:

- (a) transfecting or transforming cells with a first expression vector of claim 3 which directs expression of HG51 and a second expression vector which directs the expression of a promiscuous G-protein, resulting in test cells;
- (b) exposing the test cells to a substance that is a suspected agonist of HG51;
- (c) measuring the level of inositol phosphates in the cells; where an increase in the level of inositol phosphates in the cells as compared to the level of inositol phosphates in the cells in the absence of the suspected agonist indicates that the substance is an agonist of HG51.

31. A method of identifying antagonists of HG51 comprising:

- (a) transfecting or transforming cells with a first expression vector of claim 3 which directs expression of HG51 and a second expression vector which directs the expression of a promiscuous G-protein, resulting in test cells;
- (b) exposing the test cells to a substance that is an agonist of HG51;
- (c) subsequently or concurrently to step (b), exposing the test cells to a substance that is a suspected antagonist of HG51;
- (d) measuring the level of inositol phosphates in the cells; where a decrease in the level of inositol phosphates in the cells in the presence of the suspected antagonist as compared to the level of inositol phosphates in the cells in the absence of the suspected antagonist indicates that the substance is an antagonist of HG51.

32. A method of identifying antagonists of HG51 as recited in claim 31 wherein the first and second expression vectors of step (a) are replaced with a single expression vector which expresses a chimeric HG51 protein fused at its C-terminus to a promiscuous G-protein.

33. An antibody that binds specifically to HG51 protein wherein the HG51 receptor protein comprises the amino acid sequence as set forth in SEQ ID NO:2.

207

The genes encoding the peptides that bind to FcRn are sequenced and the corresponding peptides synthesized. The affinities of the peptide-FcRn interactions are determined using SPR and the BIAcore (Pharmacia).

The peptides are synthesized in biotinylated form to allow direct coupling to BIAcore chips *via* streptavidin (streptavidin-coated chips are commercially available from a number of sources). On- and off- rates at both pH 6 and pH 7.4 are determined using previously described methods (Popov *et al.* 1996a; Jönsson *et al.* 1991). Peptides that show the highest affinity at pH 6 and/or most marked pH dependence are analyzed further.

#### **FcRn-mediated transfer of the peptides**

Using methodology analogous to that described for Madin-Darby Canine Kidney (MDCK) cell monolayers expressing the poly IgA receptor (Mostov and Dietcher 1986) an *in vitro* assay for the functional activity of FcRn is developed. This assay allows the determination of the functional activity of FcRn in mediating the trafficking of bound ligands from one side of a cell monolayer to the other. An alternative assay would analyze transfer of (radiolabeled) peptides in neonatal mice as described previously for Fc fragments (Kim *et al.* 1994b).

For the *in vitro* and *in vivo* assays, peptides are synthesized with N-terminal tyrosines and radiolabeled using the Iodo-Gen reagent (Amersham). If a peptide contains one or more tyrosines at internal positions, this clearly is not a useful approach. If such is the case, the peptide is extended with an N-terminal glycine during synthesis, linked to the resin *via* a Rink linker (Rink, 1987) and then directly coupled to radiolabeled succinimydyl hydroxyphenyl propionate at the N-terminus. Various concentrations (1 µg/ml-1 mg/ml) of peptides are added to the appropriate side of the transwell, and transfer of peptide across the monolayer quantitated by gamma counting.

As the Fc-hinge has two FcRn interaction sites per molecule, one may prefer to prepare "repeat" peptides, that is, a peptide that has two interactive sites per molecule, in order to achieve the desired pharmacokinetic characteristics (refer to Example 6 and Table X for exemplary data demonstrating the improved pharmacokinetics achieved by having two interactive sites per protein molecule).